Hands-on Science

Education Activities. Challenges and Opportunities of Distant and Online Teaching and Learning

Edited by:
Manuel Filipe P. C. Martins Costa
José Benito Vázquez Dorrío

The Hand-on Science Network

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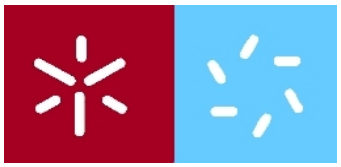

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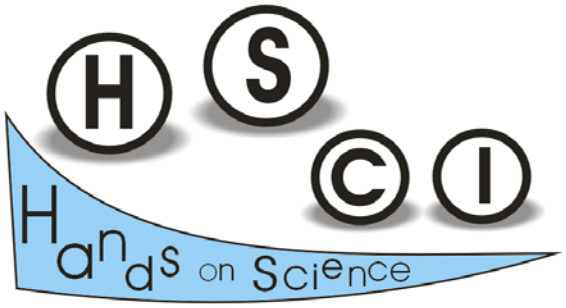

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Foreword

Hands-on Science Education Activities
Challenges and Opportunities of Distant and Online Teaching and Learning

The current COVID 19 pandemic situation has been extremely demanding to all of us. The human tragedy that daily unfolds in front of our yes, the social distancing, the uncertainety on our lives, puts a huge pressure and stress on everybody. Including, of course, on teachers and educators. Once more Science appears to everybody' eyes (with few exceptions…) as key to the solution of this problem. And fortunately, the appreaciation towards Science, and STEM, is once more increasing making the task of us science educators and teachers a little bit easier and surely even more rewarding. However, these times of distant and online Teaching and Learning demanded and are still demanding a major adjustment on the way we educate our students. We learnt new tools and methods, we adjusted to the digital to the online and to the virtual (that must be "real"…). But we are still strughling trying to find "new" anwsers to fundamental questions, that we always had to deal with, and some essentially new: how to communicate? how to lead the students to learn?... how to emotionaly relate with the students? how to "see" what they really feel? what "help" they need? how to have empaty and to make student feel that we do care and want to support them? How social distancing is being processed by our children teens and young girls and boys? The resilience of us humans is amazing and that is also true for our youngsters. They certainely suffer but resist and persist… What can and what should we do or not to do?... What digital and online tools including communication and social media can we and should we use? and how? What is true and what is fake…?

These are just a few among the myriad of different questions we have dealt with and continue trying to deal with. At our 18th annual Hands-on Science conference, we will discuss, in a friendly and open-minded way, these and many more questions from different perspectives and with diverse and innovative proposals of solution. A good number of very interesting and meaningful contributions, from a diverse range of researchers teachers educators and students, were brought to HSCI2021 to be posted for offline view at the conference website and or to be presented live online.

The book herein aims to contribute to the improvement of Science Education in our schools and to an effective implementation of a sound widespread scientific literacy at all levels of society. Its chapters reunite a variety of diverse works presented at the 18th International Conference on Hands-on Science held online, July 19 to 23, 2021.

Vila Verde, Portugal, July 15, 2021.

Manuel Filipe Pereira da Cunha Martins Costa
Editor in chief

FOREWORD

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Live Streaming Outreach: Twitch as an Alternative in Pandemic Times

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Abstract. The arrival of the COVID-19 pandemic forced scientists to leave apart their consolidated face-to-face outreach activities and replace them by online activities. Among the large number of available online platforms to do outreach, Twitch is one of the most adequate and trendy options, also working as a streaming social network. It is mostly used by young people, who see it as fresh and attractive plataform to consume live content. In this contribution the ideality of Twitch as an online platform to conduct outreach activities is analyzed and discussed. For this purpose, some examples of successful outreach activities carried out by our student chapter using this social network are presented in detail. Specifically, we present an outreach-oriented scientific photo contest award ceremony and a series of Ph.D. meetings devoted to explaining the researching activities of the candidates.

Keywords. Live Streaming, Outreach, Social Networks, Twitch.

1. Introduction

The USC-OSA chapter and USC-EPS Young Minds Section is a group of physics students and researchers of the Universidade de Santiago de Compostela (Spain) devoted to disseminating optics and photonics through face-to-face activities [1-4]. However, the current COVID-19 pandemic and the corresponding social distancing recommendations forced the group to adopt a different outreach strategy.

Online activities are great alternatives to face-to-face events in pandemic times since they make possible to join any event as well as safely interact with people without moving from your home or office. This advantage of online events has been extensively exploited to virtually reschedule lectures as well as scientific congresses worldwide. For the same reasons, we also adopted online events as an alternative to our traditional face-to-face outreach.

2. Choosing a platform

Once the decision of doing online activities is taken, it is necessary to choose a platform to properly host the events. As a student chapter, our first option was using the institutional platform that our university employs to manage the online lectures. At first sight, it seemed to be the best option since undergraduate students are used to work with it, and, in addition, external people could also join the events.

However, we soon realized that maybe using the same platform as our university uses for the lectures was not such a good idea. After conducting the first events, we discovered that students that were interested in our activity were neither comfortable nor participatory during the event because of the platform. As we used the same platform that they used in their lectures, the feeling that it was not an outreach activity but a continuation of their lectures was very noticeable. Since the pandemic stopped us from having social events and limited the number of stimuli we are exposed to, finding a more disruptive platform than the standard academic one was required. After an extensive search, we determined that the trendy social network Twitch, was the platform we were looking for.

3. Twitch for outreaching

Twitch is a video streaming platform and social network that is devoted to sharing live transmissions of video games, talks, and creative content. As a social network, it connects people from different places around the world who share common interests and tastes. Currently, Twitch is a growing platform whose number of users has been rising for the last few years. In fact, according to available data [5], Twitch is one of the most widely spreaded social networks in Spain, being employed by 17.4 % of the spanish internet users, most of them people under 30 years old. An evidence of this increasing popularity is that recently, a Spanish streamer was able to

gather more viewers than several public spanish TV channels during 2020 New Years' Eve [6]. For these reasons, Twitch is an excellent media to bring science closer to people that could not be reached in any other way.

On the other hand, Twitch is more than a social network since it also is a disruptive streaming platform: fresh, catchy, and friendly. As a streaming platform, it is attractive to young people, from school students to undergraduate students or Ph. D. candidates, which are the target audience of the outreach activities considered in this contribution. Moreover, it offers an appealing interface, an interactive chat, and an easy usage. Anyone can join live emissions just by clicking on a link, both from smartphones and computers, and without the requirement of installing any application. Lastly, another advantage of Twitch is that after doing an activity, the live emission is automatically saved and available in public for anyone who wants to see it in delayed format within the 15 days after the show. We found that people that could not attend some of our live events because of schedule limitations, watched them afterwards thanks to this functionality. Moreover, the creators of the content are able to download their live content to upload them to another video platform, such as Youtube.

4. Hosting activities on Twitch

In the following lines, we present two live-streaming activities our chapter carried out on Twitch during the last year.

4.1. The bright side of everyday life

"The bright side of everyday life" is a transmedia activity based on a photo contest to commemorate the International Day of Light (IDL) 2021, celebrated on May 16th. Being a transmedia activity means that it is an activity that was explicitly designed to have different parts in different platforms but keeping a common narrative thread between all of them. The photo contest itself consisted in identifying, capturing and explaining a daily optical phenomenon. A jury selected the ten finalist pictures that were afterwards published on our Instagram profile (a popular photography social network) where a popular election in terms of likes was held. However, as a transmedia activity, the photo contest was not the whole event, but there was also an outreach-oriented award ceremony that took place on Twitch.

We exploited the close and relaxed format that Twitch offers to transform a standard award ceremony into a full outreach event. Five of our members showed one by one a large number of participant pictures, even those that were not finalists, to the audience. Each picture was live analyzed and discussed in a friendly and close format. After showing the non-finalist pictures, we tried to give some thrill to the event by sequentially analyzing the finalist pictures. At the end of the event, we announced the winner and, as a surprise, the author of the winning picture joined the event. She explained the physics behind her picture and shared some personal experiences with the hosts of the events and audience.

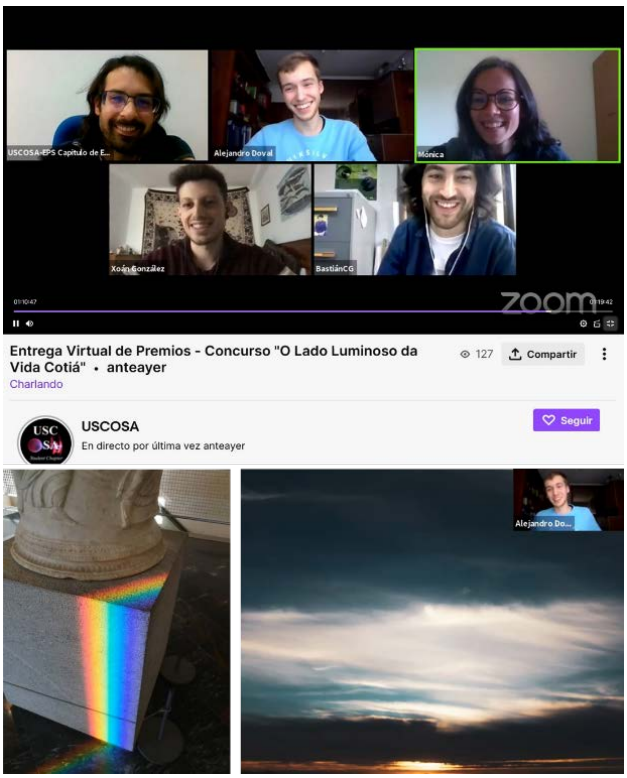

Figure 1. Some screenshots of the outreach-devoted award ceremony of the *"The bright side of everyday life"* photo contest

With respect to the reception of the audience, it was very satisfactory: the event was live-followed by around 30 people. However, since the event was also available on Twitch to being watched on a delayed basis, the total number of views was significantly increased. We discovered that almost 120 people watched our event in a delayed fashion. Consequently, we impacted 150 people with

this event.

4.2. Doc-Talks

The Doc-Talks is a career development program which consists in a monthly meeting with two Ph.D. students which are invited to explain their research. As the previous activity, the meetings are conducted in Twitch. Each Doc-Talk is divided in two parts. In the first one, the invited Ph.D. candidates talk for 15 minutes about their research from an outreach perspective. After each talk, there is some time for questions. These questions are done both by the hosts of the event (i.e., chapter members) as well as the audience using the Twitch chat. Because of the great transversality of the Twitch users, these talks are followed by people from very different backgrounds, including people without scientific training at all. In the second part of the event, hosts and speakers share their opinion about a topic that is different from session to session.

These discussions are open to the public who are offered the opportunity to join the live streaming. They are conducted in an informal way and treat topics of interest for different collectives, from undergraduate students to Ph. D. candidates. Some examples of the covered topics are: what researcher life is about or the role of grants in the Ph.D. stage.

Figure 2. Some screenshots of one Doc-Talk session

Summarizing, the Doc-Talk program is not only a fantastic way to promote networking between Ph.D. students, but also a reat mechanism to help undergraduate students (and even people beyond academia) to discover how a Ph.D. works and the wide variety of research fields within our university.

5. Conclusions

The arrival of the pandemic forced us to find new outreach alternatives to face-to-face activities. Streaming events are an excellent option to do outreach respecting the social distance but keeping interaction with the public. Among the large number of available streaming platforms, Twitch stands out as an ideal option. It is a trendy platform that provides good functionality together with engagement with young people. The two activities presented in this paper are excellent examples of the potential of Twitch as outreach media.

6. Acknowledgements

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Monitoring of Environmental Parameters at Schools for the Improvement of Academic Performance and Airborne Diseases Control

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Abstract. This paper presents a network of environmental sensors developed for the continuous monitoring of variables like temperature, relative humidity, light and carbon dioxide at high schools in Galicia, Spain. The information provided by the sensors can be transmitted in real time and stored at a server for processing and public diffusion. In particular, the carbon dioxide levels serve as an indicator of the air quality to help prevent diseases transmission and improving the welfare and academic performance of students. The development of the meters has been supported by an innovation project granted by the Government of Galicia.

Keywords. Environmental Monitoring, Electronic Sensors, Academic Performance, Disease Control.

1. Introduction

Indoor air quality is a factor of great importance for the control of airborne diseases like COVID-19 in educational buildings. A low oxygen level or an excess of carbon dioxide can also cause fatigue and cognitive impairment [1], with serious consequences on academic results of the students and their welfare and health.

On the other hand, the energy performance of educational buildings is strongly affected by factors such as excessive ventilation and heating schedules, in addition to intrinsic ones like construction defects or poor insulation. In order to achieve a balance between these different needs, it is essential to have complete information about the environmental parameters of the buildings with a large number of measurement points and a wide temporal interval. All these data should be centralized and easily accessed for further processing.

To achieve these objectives a team of teachers of two high schools (IES Escolas Proval and IES Val Miñor, Nigrán, Spain) and the local company Hermes Smart Control have started a cooperative project for the development of electronic meters of variables like temperature, relative humidity, light and carbon dioxide levels (Fig. 1).

The project has started during the current situation of COVID-19 pandemic, but it goes beyond this context and seeks the improvement of energy efficiency of the schools and the study of the relationship between the academic performance of the students and the environmental parameters of the buildings.

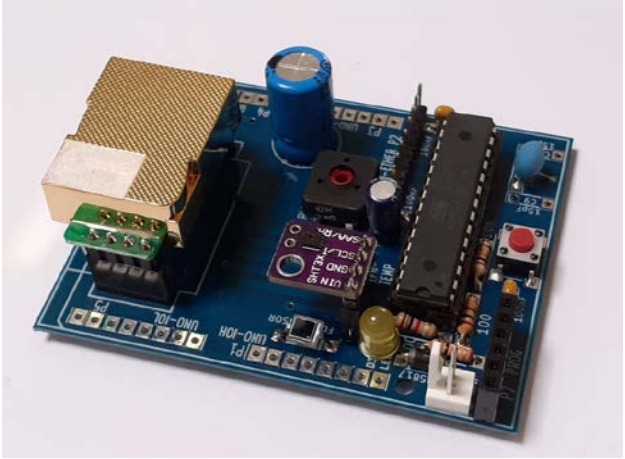

Figure 1. One of the sensor boards of the project

Our proposal will create prototypes of meters that can be connected to the data network of the schools and will send information continuously to a server (located in each center or external). Other prototypes will store the data in a memory or sd card. In the market there are many equipment [2,3] that can meet these requirements, but they are very expensive (especially if it is planned to install them in all the classrooms) or have bad quality sensors. In many cases the measurements are made over periods of short duration and do not provide sufficient information for a systematic study of the conditions of the environment. The meters should be economical, reliable, with a variable number of sensors and an installation procedure simple enough so that anyone in the schools can do it without high technical

qualification.

We have planned to develop different prototypes that can adapt to all situations: with and without network interface, screen, keyboard and sd card. The control boards are based in Arduino microcontrollers, Raspberry Pi and others. All of them will have Open Source Hardware and Software to allow an easy reproduction of the project in other institutions.

2. Project Background

The entities involved in the project have a wide experience in innovation. The Department of Electronics of IES Escolas Proval has been developing during the last years several applications with microcontrollers that have been presented at international congresses like HSCI or TAEE [4-6]. As an example, the school has designed an electronic weather station that has been providing data during the last fifteen years. This station continues the weather research started at the center from its foundation in 1907, and continued by Prof. Salvador Rodríguez Muñoz since 1987 as an associated center of the Instituto Nacional de Meteorología. The automatic station provides information through its own web page and the data can be easily retrieved. This project received a 2nd innovation award granted by the Instituto Enerxético de Galicia (INEGA) in 2007. The experience gained in the development of this system is the starting point for the current project, because its structure and elements are similar.

The current situation of COVID-19 pandemic has motivated many high schools to start programs of measurement of carbon dioxide concentration. One of this centers has been IES Val Miñor at Nigran (Spain), that at the beginning of this course has purchased meters and acquired data that will help in the definition of the characteristics of the prototypes of the project and its verification.

The industrial partner of the project is the company Hermes Smart Control based at the Bussiness Center of Polígono Porto do Molle in Nigrán. This is a recent foundation company but has a highly qualified R&D team with many years of experience in industrial processes measurement equipments. The company is involved in many projects promoted by Business Factory Auto (IGAPE, Galicia), the Digital Innovation Hub Industry 4.0 (Castilla-León, Spain) or Growth Train (Denmark). The presence of this company in the project guarantees the technology transfer of the results and provides employment opportunities for the students of Vocational Training of IES Escolas Proval.

3. Objectives and Schedule of the Project

3.1. Objectives of the Project

This project has many applications in science and technology educations. Among others, the main objectives of the project are:

- Development of measurement systems of different environmental parameters with data acquisition, storage and communication capabilities.
- Preparation of innovative practical lessons for students of electronics and technology about sensors, data acquisition, communications and programming.
- Technology transfer between educational centers and companies for the development of new systems and products.
- Improve the employment opportunities of the students through the participation in a real R&D experience.
- Acquire a better knowledge about the environmental status and energy efficiency of the educational buildings for the implementation of innovative solutions.
- Promote the interest of students of all levels about environment and energy efficiency.

3.2. Schedule of the Project

The project has been divided into a set of tasks that will be assigned to a team of teachers and students in each center. In some cases the same task can be shared by two teams with a coordination procedure.

Due to the COVID-19 pandemic it was not planned to make presential meetings, instead we used a variety of communication means like email, message groups and online learning tools like Moodle or others.

The phases of the project are:

1) Initial studies and planning.
2) Design and construction of the prototypes.
3) Installation of the prototypes and real measurements.
4) Evaluation of the results, diffusion and technology transfer.

The tasks related to the design and construction of the electronic prototypes were initially planned for the last months of course 2020-21, serving as practices and small projects for the students of Vocational Training at IES Escolas Proval. But the ventilation regulations established by the educational authorities forced a change in the scheduling in order to obtain information about the air quality, starting these tasks at the beginning of 2021 with the first measurements obtained as soon as february 19th.

The tasks of diffusion and technology transfer were scheduled at the last months of 2021, but have also been advanced for the same reasons. In particular, the partner company Hermes started its own development of dioxide meter to meet the government regulations applied to restaurants and other business.

4. Electronic Prototypes

4.1. Arduino Connected Meter

This meter has been designed to be compatible with Arduino [7] boards and IDE for ease of programming and development. An Atmega328P-PU microcontroller is connected to an ethernet module with a Wiznet W5500 chip [8] which deals with TCP/IP communications and creates a small web server that can be used to check the last data and for configuration. We have chosen a cable connection (RJ45) instead of wifi because it is more widely available in a typical classroom and also for reliability reasons. The ethernet module is independent of the microcontroller board and connects by an IDC-10 flat cable strip. This configuration allows the acquisition of different modules available in the market.

The selection of the sensors is an important part of the design process. In this case we tried to keep a balance between cost and performance, for this reason we have chosen a Winsen MH-Z19C NDIR carbon dioxide sensor [9], a Sensirion SHT30 temperature and relative humidity sensor [10] and a BPW34 photodiode for light detection [11]. This NDIR sensor has a low cost maintaining the good characteristics of this technology of detection.

The prototype has an usb power connector, what allows the use of many types of power supplies recycled from old phones, tablets or computers.

This prototype has not screen or keyboard to reduce cost. The data can be consulted connecting directly to the micro web server of the meter or on the web page of the project. In the web page each meter has its own space following the same format, that for meter 1 is:

http://codos.meteoproval.es/blog/medidor-1

We have designed our own printed circuit board (pcb) compatible with Arduino Pro-Mini boards that can be connected by usb to a computer for programming and checking purposes. The electronic schematic of the meter is shown in Fig. 2.

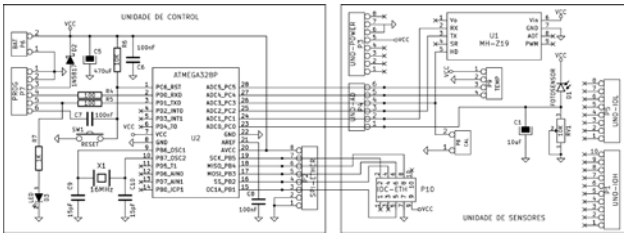

Figure 2. Sensors board schematic

Fig. 3 shows the board design (left) and component map (right). The pcb design is simple enough to make the boards at the high school or send the files to an external manufacturer.

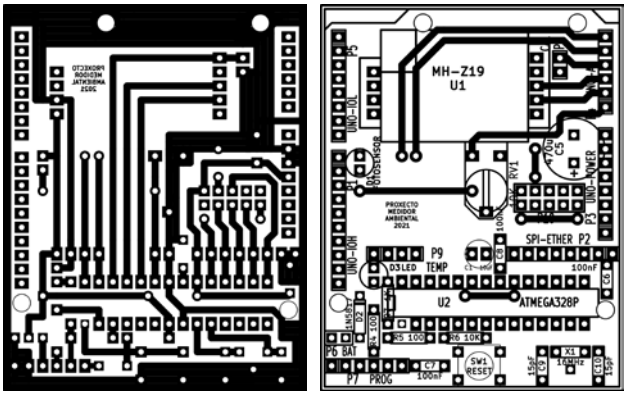

Figure 3. PCB of the prototype: layout and components

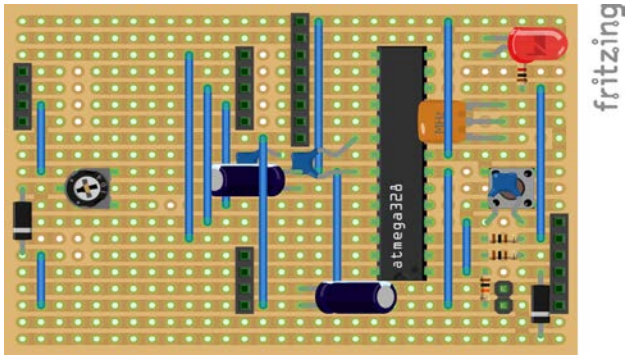

Figure 4. Stripboard schematic

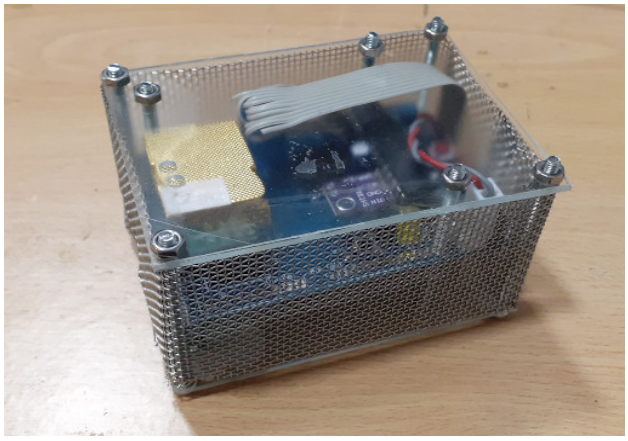

Figure 5. Finished prototype in its case

Another option is to mount the components using a breadboard or stripboard, using the following diagram made with Fritzing (Fig. 4).

Figure 6. Assembly of boards at IES Escolas Proval

The control program of the board has been made using the Arduino IDE and several libraries for ethernet communications and sensor reading. The code is freely available at the web page of the project [12]. For the carbon dioxide sensor we have used the MH-Z19 library by Jonathan Dempsey [13].

The design and construction of the first prototypes has been made at IES Escolas Proval with the participation of teachers and students of electronics degree “Mantemento Electrónico”. Fig. 6 shows the students during the soldering and assembly of the boards.

4.2. Ventilation educational model

The objective of the educational model is to be able to control a ventilation system for two rooms. The opening of two gates controlled by a servomotor and the speed of an air extractor will be controlled. In this way the air flow will be controlled and therefore the time in which the room is ventilated.

In addition, the graph of the main system variables can be observed locally on a 3.4 inch touch screen and on a data server that will allow studying the history of the stored data. As system variables, the CO2 concentration of each cabin, the speed of the extractor and the condition of the vents will be measured. Fig. 7 shows the complete assembly of the system.

An interesting feature of the educational model is that the control cycle is repetitive. If we keep the CO2 valve in the same position, the CO2 concentration rate is always the same. This allows testing various speed control algorithms: on-off control (Fig. 8), proportional control, PID control and others.

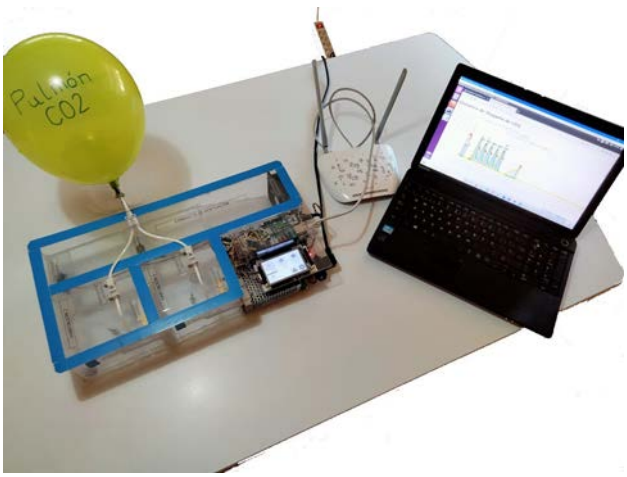

Figure 7. Assembly of the ventilation model

The control equipment chosen is an Arduino Mega 2560 [14]. It has enough memory to handle a large amount of data. It

also allows testing multiple hardware scenarios. This facilitates the scalability of the prototype.

The model will have communication to be able to store the data in a MySQL-Apache server that allows visualizing in a graph the CO2 variables, the motor speed and the status of the grids. An Ethernet Shield card will be used for this. This will allow the Arduino to connect to the data server network.

To be able to control the model locally and to be able to see the graphics, a touch screen will be used. In this case, Nextion's Enhanced model will be used [15]. This screen allows you to efficiently refresh up to the simultaneous measurement of four variables. In addition, it incorporates a real time clock (RTC) that ensures the time by means of a button battery. It allows to detail in the graph the temporary indication of the RTC.

Figure 8. Control algorithm graph

The CO2 sensors are of the NDIR type with a measurement range between 400 and 2000ppm. The model is the Winsen´s MHZ19C [9]. These sensors allow reading through serial communication and have a calibration pin.

The extractor is a 12V fan used for air cooling of computer equipment. It is a motor that allows speed control. Particular care must be taken with the orientation for it to properly exhaust air. It also has hall effect sensors that allow to control revolutions over time and therefore speed. The pinout of this type of device (Fig. 9) depends on the manufacturer but we can find fans with three or four wires.

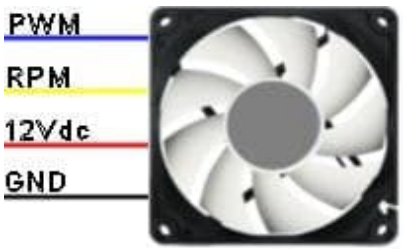

Figure 9. Pinout of a typical computer fan

In Fig. 10 you can see the connections of the elements that are part of the system. A video tutorial that shows the different parts of the assembly and the control procedure is available in galician language [16].

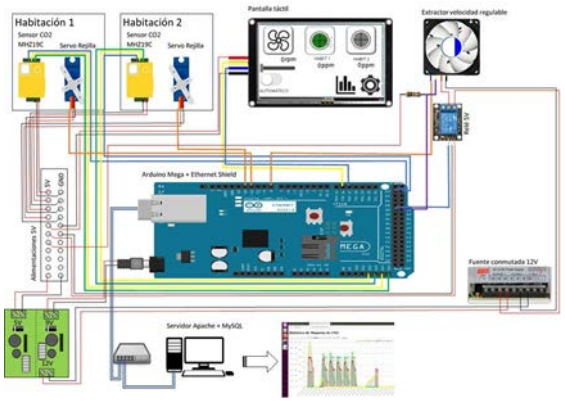

Figure 10. Ventilation system schematic

The data server is based on free software. The software has been installed on a Ubuntu16 version. The option to choose this version of the operating system is due to its low hardware requirements.

In order to store and exploit the data provided by the Arduino kit with Ethernet Shield sensors, we must install a LAMP server. The installation of this server is carried out basically by installing the Apache web server packages, a MySQL database manager and the php language to be able to program the graph and access to the database data.

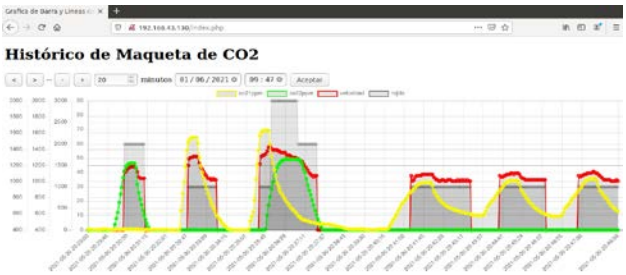

Figure 11. LAMP server data presentation

From the graph page (Fig. 11) you can browse the data and view a window with more or less amounts of them. Chart.js package has been used to program the graph which allows its free use under the MIT license.

4.3. Raspberry Pi Prototype

The Technology Department of IES Escolas Proval is developing a prototype based on a

Raspberry Pi 2 [17]. The use of this hardware increases the cost of the CO_2 meter compared with Arduino boards, but it simplifies the presentation of the data through a touchscreen. The software used was the programming IDE for Processing (PDE), running on Raspbian operating system. The values provided by the MH-Z19C sensor are read using its PWM output. Data are captured with a frequency of one sample by minute.

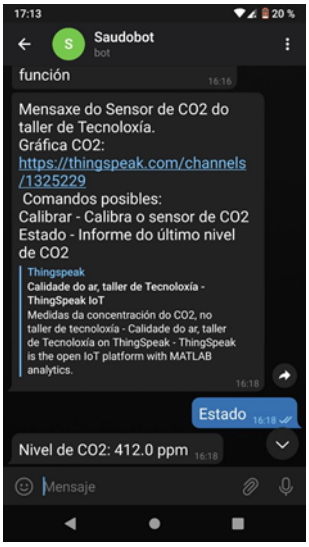

Figure 12. Example of Telegram message

These values are sent to the internal server of the educational center and also to the Thinkspeak website [18]. An interesting functionality is the use of a Telegram chat to read the last message. The user of this chat can send commands from a mobile phone, tablet or computer. Currently it accepts two commands: */State* and */Calibration*. The first command indicates the system to respond to the chat with the level of CO_2 and temperature in real time. The second commando initiates the calibration procedure of the sensor. Bidirectional communication with Telegram allows the setting of high or low CO_2 level alarms or the indication of an abnormal operation of the equipment with a few lines of code. Fig. 12 shows an example of use of the Telegram interface.

The use of Raspbian operating system allows the remote programming of the prototype via a VNC client. For the connection of analog sensors such as the LM35 temperature sensor it was necessary to use an external analog to digital converter, since the Raspberry Pi has no analog inputs. For this purpose we have used a Microchip MCP3208 integrated circuit. This prototype is installed in the Technology workshop of IES Escolas Proval (Fig. 13).

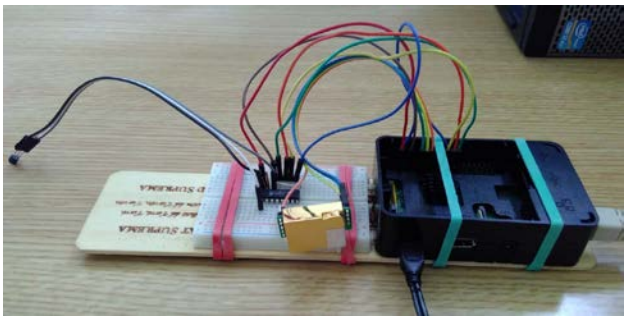

Figure 13. Raspberry Pi prototype

4.4. Qair Hermes Meter

Figure 14. Qair meter designed by Hermes Smart Control

The company Hermes Smart Control is developing its own carbon dioxide meter named Qair. The meter has a screen that indicates the level in ppm and a three colour code that allows users to easily check the status with a quick view. Its shape remembers a 'vieira', the well known icon of the Way of St James and also a symbol of galician gastronomy. Fig. 14 shows a picture of the first version of the meter, that has been presented to the media in May 2021 [19].

5. Preliminary results

Since the first measurements in february we have installed a total number of 18 meters in three high schools of Val Miñor (IES Escolas Proval, IES Val Miñor and IES Primeiro de Marzo of Baiona). The data acquired during these months permits to make a first analysis and provide information for later stages of the project.

5.1. Data acquisition and analysis

As an example of the results obtained we present an analysis of the data obtained during an exam day at IES Escolas Proval. In this date (May 3rd) the ventilation was insufficient and carbon dioxide levels achieved levels as high as 1680 ppm at 9:34h, 1610 ppm at 12:45h and 1213 at 17:16h. The mean level during the morning was 1005 ppm (8:45-14:30h) and during the afternoon was 813 ppm (16:00-18:10h). This data exceeded the recommended values and probably had a deep impact on the welfare and academic performance of the students. Fig. 15 shows the graphical representation of the carbon dioxide levels in this date.

5.2. Comparison with reference meter

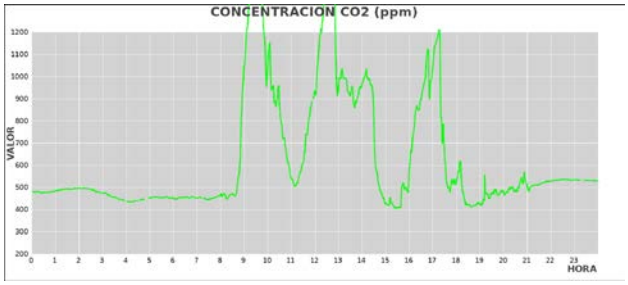

Figure 15. CO2 levels on May 3rd

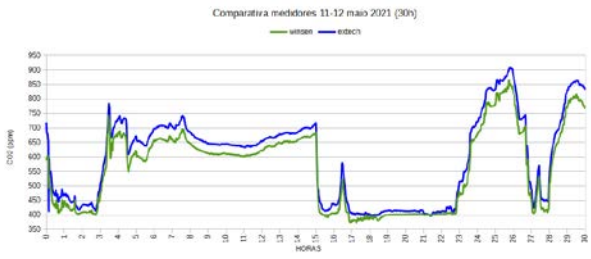

Figure 16. Time comparison of meters

An important part of the project is the comparison of the prototypes with a reference meter which gives information about the quality of the measures obtained. For this purpose we acquired an Extech CO-260 [20] carbon dioxide meter (manufactured by FLIR). This meter has a Senseair K30 sensor which has better characteristics than Winsen MH-Z19C. The results of these comparison are represented in Fig. 16 (evolution during and interval of 30h) and Fig. 17 (correlation between measurements). Also the regression coefficients have been calculated showing a good coincidence between the two types of meters.

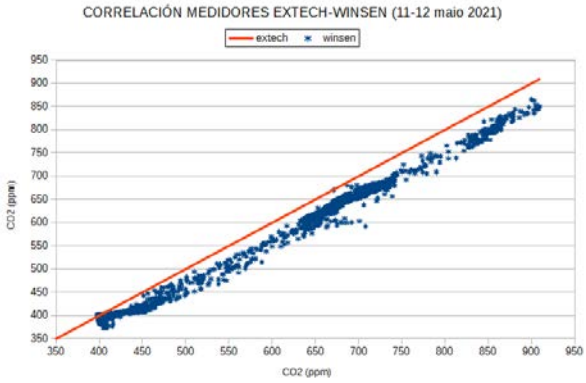

Figure 17. Correlation of measurements between meters

5.3. Calibration procedure

NDIR sensors have automatic (ABC) or manual calibration procedures that can be applied according to the working environment. For this project we have chosen the manual calibration because in a typical classroom there is no guarantee that air renovation achieves the base level of 400 ppm. This means that calibration should be revised at least every month (or two weeks if possible).

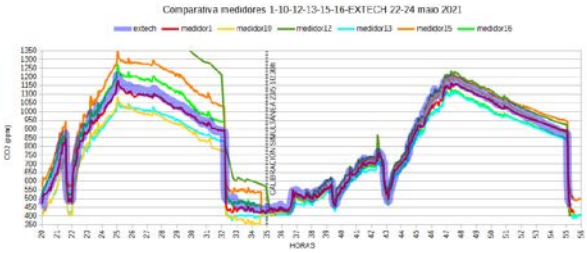

Figure 18. Calibration of meters

Figure 19. Calibration setup

Each set of new meters have been calibrated before placing them in the

classrooms. Fig. 18 shows a representation of the measurements of the meters before and after the calibration procedure, showing a good convergence of the values.

Fig. 19 presents the calibration of a set of meters at the same place, with all the meters connected to the same switch and sending data to the server at the same time.

6. Educational Activities: the COVID Sentinels of Val Miñor

In the next paragraphs we will present some of the activities carried out in different stages of the project.

6.1. Introduction

Since 2020, March 13th the Spanish educational institutions had to adapt to a new situation of "emergency remote learning". The current course 2020-21 has been a success not only by the low infection rates but the ability to take educational advantage of this circumstances.

One result of these efforts has been the cooperation between IES Val Miñor and IES Escolas Proval and the set of activities that we have carried out, both individually or as a joint effort.

At IES Val Miñor this project started with the departments of History and Physics, but during the course many other teachers were involved: Biology, Technology, Mathematics, Galician Language, French and others.

Some circumstances boosted the development of the project: the students of 1st grade of ESO were expected to work in projects and the department of Physics had started a study of CO2 measurements with commercial meters with the cooperation of Geography and History teachers.

The work of the students was divided in three main themes to let the students understand the current situation and its historical context: the Globalization, the Climate Change and the Global Pandemics.

- The Globalization: we have planned activities to understand its influence in economics, politics, culture...
- Climate Change: study of the meteorology and climate and its influence in our life.
- Global Pandemics: analyse the "Greatest Killers in History" that were not persons but virus and bacteria: the Black Plague, Spanish Influenza and others. Also will be studied its relation with the evolution of world population through activities like population pyramids and others.

6.2. Preliminary works

At the beginning of course 2020-21 the management and Physics department of IES Val Miñor started a program for the analysis of the carbon dioxide concentration in the classrooms as an indicator to adopt ventilation measures during school hours.

Due to the high cost of the commercial meters and the low budget of educational centers, it was decided to acquire a single meter for a total number of 20 classrooms and about 400 students. The solution adopted was to periodically move the meter from classroom to classroom. This solution did not allow a rigorous study of the data, attending to environmental conditions (humidity, temperature...) and people (number, age, sex, weight...) that influence the measurements. After a few days it was clear the need to make periodic measurements in all the spaces to contrast the results.

At this point it was proposed to participate in the innovation project with IES Escolas Proval. The installation of four new meters allowed to make a selection of classrooms attending to their orientation, number of students and distribution of doors and windows.

An important contribution to the project was the elaboration of different documents and materials for the proper installation and working conditions of the meters. These documents also served as educational information for the students that cooperated in the project.

- INSTALLATION MANUAL: Physical conditions of the classroom and position of the meter. As general conditions, half of the windows should be always opened, blind opened as much as possible except in case of rain and the

door always opened. The meter should be placed far from the door or windows. If it was on the teacher's table it should be far from air flow from the computer fan and the students (and the teachers) should avoid to be close to the meter. Some students blowed to the meter as a joke, but soon they discovered that it was registered in the graphs and stopped doing it.

- DATA REGISTER: the students had to make each day a document with the following information: number of meter, classroom, responsible's name, hour, number of students pero hour, weather conditions and any other information related to the measurements (Fig. 20).

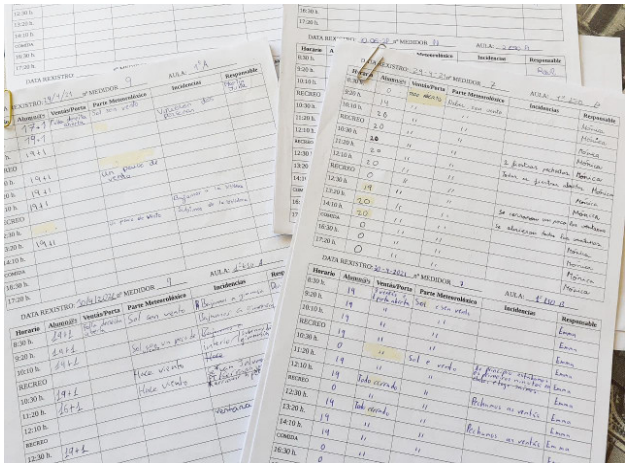

Figure 20. Example of data registers

Figure 21. Installation Toolkit

- INSTALLATION TOOLKIT: in a typical high school it is not easy to find the materials needed for the installation and connection of the meters. We created a "toolkit box" (Fig. 21) with scissors, ties (to keep the cables together), 5-meter long usb cables and ac cables (many times the mains sockets are not in the best place) and the data register sheets. These kits were placed at the teacher's room, where there is (almost) always people to control the material and give it to the students.

6.3. Classroom Measurements and calibration

Before starting with the measurements all the teachers were informed by messages and cartels in the classrooms. But the most important task before starting was the selection of the human resources that would be in charge of the measurements: the students. They shoud take care of the meters and detect any event that could affect the measurements. Without their cooperation the information provided by the meters would lack important data to understand what was happening.

The process of registering data, analysis and improvement proposals was carried out by 25 students of all the groups classroom that voluntarily decided to participate, to whom we would like to thank for their cooperation. It was needed to create a schedule to assign days to all the participants. Since then they were in charge of registering the daily data, passing the sheets to the following student and at the end of the week they give them to the teachers. The students also watched the data and graphics stored in the web of the project. This information allowed to detect failures, need for calibration and jokes of some students that distorted the measurements.

Fig. 22 shows one of the meters in a classroom at IES Val Miñor.

Figure 22. Meter in one of the classrooms

The calibration process of the meters was reserved to the teachers of the project because

it needed to access restricted data and characteristics of the meters. The calibration should follow the strict requirements indicated by the manufacturer of the dioxide sensors. The meter must be in clean air (for example outside the window), with constant temperature, without direct sunlight and no air flows nor people close to the meter. All these conditions should be kept for a minimum time of 15 minutes. For this reasons it can only be made in the mornings during school breaks or in the afternoon when there are not classes.

The meter should be connected to the network and from a computer must be checked the current measurement until it maintains a stable level. At this moment it must be activated the calibration option in the internal server of the meter to start the internal algorithm. After that it should be checked again to verify that now the level coincides with the atmosferic base level (about 400 ppm). If there is any problem the calibration process should be repeated until it is correct.

6.4. Final activities and results

The main diffusion activities (congresses, participation in exhibitions and science fairs) were planned for the last months of 2021 and 2022. This course we made an online photograph contest that was organized through the virtual classrooms of both high schools.

Figure 23. Announcement of the contest and winning photographs

The contest had the advantage that all the students were already registered in the online tools and had been trained to use its resources. There was a few participation but we expect to repeat the experience with higher success. The information about the contest and winners have been published in the web pages of both centers [21-22]. Fig. 23 shows the information at the bulletin board of IES Val Miñor and Fig. 24 shows the winners at IES Escolas Proval.

Figure 24. Award winners at IES Escolas Proval

7. Conclusions

In this paper we have presented a cooperative project made by two spanish high schools, IES Escolas Proval and IES Val Miñor and the company Hermes Smart Control. The project was aimed to the development of environmental meters with different sensors and capabilities. Some prototypes have been already made and are acquiring and storing data to provide information about the ventilation of spaces and to improve the welfare and academic performance of students. The company Hermes is developing its own meter for restaurants and other business.

Many students of the educational centers were involved in the project and were responsible for the meters, the data registers and external conditions. This activity helped them to became aware of their own skills and feel valued.

8. Acknowledgements

The authors would like to thank the students of the Vocational Training Degree “Mantemento Electrónico” at IES Escolas Proval and the students of ESO at IES Val Miñor for their important contribution to the activities of the project. Also to Xunta de Galicia for funding the Vocational Training Innovation Project entitled “Continuous monitoring of physical parameters for the improvement of environmental quality in educational buildings”.

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Young Science Students as Asimov's Followers

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Abstract. In the COVID context, with the impossibility of carrying out face-to-face lessons, we designed some activities in a virtual approach on science, Asimov, in his birth anniversary (2020), and science-fiction. These activities allow the diversity of students increase their motivation towards science. Some activities were: a) short history of chemistry, Asimov's book, was used in chemistry course; b) reading science fiction leads students to promote creative thought; c) a game cards with the most Asimov's science fiction books; d) short stories around science fiction were presented in a competition; and e) the impact of this educational method has been considerable between participants.

Keywords. Asimov, Diversity of Education, Reading, Science-Fiction.

1. Introduction

Science is a personal activity. Scientists, with a few exceptions, haven't used their knowledge neither for desire of glory nor for material reward. Usually, they apply science for satisfying their own curiosity about how the world works.

Chemistry is a captivating field of study. Theachers, students, adult and old people can find a quantity of natural phenomena that sometimes seems so incredible that we could thing that we are talking more about magic and science fiction than talking about chemistry.

Lamentably, according to the 2018 Social Perception of Science Survey [1], more than half of Spain people have troubles to understanding science and technology and more than 40% believe that, in Spanish education, the level of science and technology is low or very low.

In addition, an important part of Spanish secondary school students do not pay attention to science subjects. Unfortunately, this lost of interest for science studies between young students also takes place in Europe [2].

Students say that they are not good at science because “they are literate”. They create a wall against science from the first science session. For this reason our society suffers a serious science deficit. Secondary science teachers are seriously alarmed when they find that their students come to chemistry class with very little motivation and with a lack of interest. All this has been worseen by the pandemic.

There are many reasons why young people do not increase interest for science. However, a connection between attitudes towards science and the way science is taught could be an excellent reason.

Given the diversity of students or the educational level mixture into a classroom and their personal interests, it is necessary to consider this diversity in a specific way that allows their individual development. Secondary school science teachers must be able to combine the emotional and intellectual involvement of young students with the natural phenomena, science and tecnology.

The traditional approach where the student was a passive subject who basically received information from the teacher is close to finish, and a new advance emerged. In this new educational view, students must play an active role in the construction of their learning. This is only possible if we make a change in the teaching methodology that allows both teachers and students to make the "role change".

In this context, COVID included, with the impossibility of carrying out face-to-face activities, the Official College of Chemists of Catalonia [3] (Col·legi Oficial de químics de Catalunya, COQC) in collaboration with the Department of Biochemistry and Molecular Biomedicine at the University of Barcelona (UB) [4], channelled effort into designing a virtual approach on Asimov for science students.

2. Isaac Asimov

World Health Organization [5] defines COVID-19 as an infectious disease caused by a newly discovered coronavirus. Most people

infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special cure. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness including death.

COVID-19 and the population confinement has made almost unnoticed that 2020 has been the centenary of the birth of Isaac Asimov, born January 2, 1920, Petrovichi, Russia - died April 6, 1992, Brooklyn, New York, U.S.A. [6-7].

He pursued a scientific career, received a doctorate in chemistry from Columbia University and was a professor of biochemistry, but in addition, after a few years, he devoted himself fully to writing and, especially, to science fiction, science, and history of science.

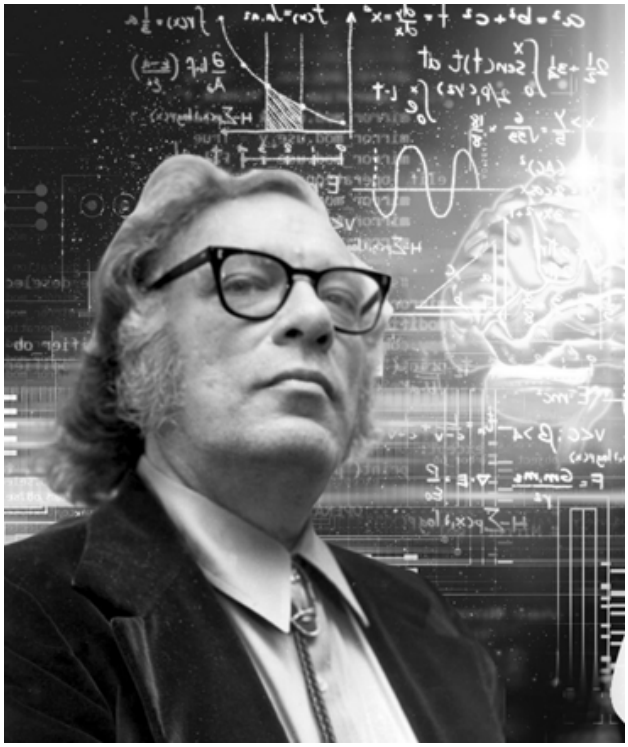

Figure 1. Asimov as a scientist

Many of his books can be used in the teaching of chemistry, physics, astronomy or biochemistry. Asimov began contributing stories to science-fiction magazines in 1939. He sold his first story, “Marooned off Vesta” to Amazing Stories.

The aim of these educational activities was to honour the figure of Isaac Asimov, the scientist, and to promote the reading of stories around science and science-fiction, and reading and creating science fiction stories between students interested in it.

3. Activities

Changes in education involve imagining the future of learning and attempting to find new activities to develop aspects of this future. These activities were planned with Asimov's lectures in a virtual context for COVID-19 context. They were designed for university students and for secondary school students interested in chemistry, in science and science fiction.

This approach seeks to promote creative thought and encourage students to really think about science and chemistry, the work they are doing at university and secondary schools.

3.1. Short history of chemistry

If we want to motivate high school students to the study of science, specifically chemistry, should be carried out with the help of the history of chemistry.

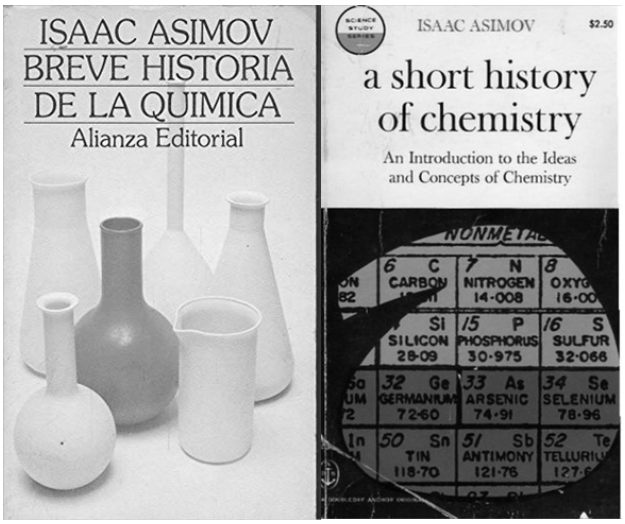

Figure 2. A short history of chemistry, book in Spanish

Fig. 2 shows the Asimov's book "A short history of chemistry" both versions, in English and in Spanish [8]. This book was used in secondary schools and university classrooms. In an effort to increase the interest in chemistry and also in science we proposed some activities on Asimov's book.

On the 15th of November, St Albert the Great: Patron Saint of Scientists day, we

proposed activities on the History of Chemistry. They were "History of the atom" and "History of the Periodic Table" aimed at secondary school students. Women in chemistry, history of chemistry from ancient history to the present, and the top chemists were designed for high school and university students.

Students greatly appreciated the opportunity to have a different way to studying and working chemistry that increased their knowledge.

3.2. Reading science fiction

Reading science fiction leads students to promote creative thought and encourage students to really think about the concepts and subjects they are studying.

Schools and classrooms together decided which science fiction Asimov's book students worked.

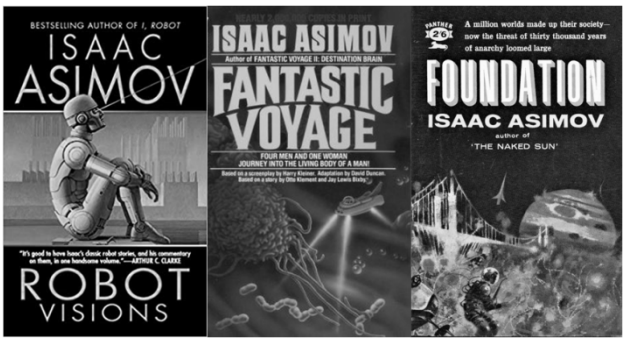

Figure 3. Three Asimov's science-fiction books

Fig. 3 shows the final three Asimov's books chosen by students and schools. The most worked was Robot [9], second was Fantastic Voyage [10] and the third was Foundation [11].

Students had to sumarize part of the book and had to formulate some questions and new scientific, technical and logical concepts.

Most of the students considered the science fiction and worked it in COVID-19 conditions a valuable experience. The majority desires to repeat this experience in the future.

3.3. A game cards

Games can be used as a support tool to complement traditional teaching methods to improve the learning experience of the learners while also teaching other skills such as following rules, creativity and teamwork [12-13].

A game cards with the most read, the most important and the most recognized Asimov's science fiction books was created with students' input and teacher's supervision.

The game, named "Asimov's Books", was designed to show the most Asimov's science and science fiction books voted by students. The game intention was to improve students' science and science fiction knowledge by playing with them.

Figure 4. Card game with fifteen images about Asimov's science-fiction books

To play this game you need: Five cards and the game rules.

The first card, in Fig. 4 you can observe this card which contained fifteen different pictures representing fifteen different Asimov's books. They are numbered from 1 to 15.

The remaining four cards contained each one eight different pictures from eight Asimov's books in the first card.

The game rules are the same showed in "Playing with bioelements" [14].

As a didactic resource card game "Asimov's books" can be useful for science teachers from different educational levels.

3.4. Short stories around science fiction

The objective of the short stories around science fiction competition was to honor the figure of Isaac Asimov and promote the creation of stories around science fiction. Then, some prizes were given.

More than thirty stories were presented, some with great quality and with a common topic: the vast majority were related to the world of robotics.

The three winners with the first expression:

- Coffee with a lug of sugar (*Cafè amb un terrós de sucre*) by Victor Canalejas Tejero. "The commission of the project that would take the man (really a woman) to the moon Europa was meeting to evaluate the Multipurpose Humanoid Robot, Rhupol, versatile and multifunctional..."
- The programmed humanity (*La humanitat programada*) by Luis Ángel Aranda Cuadros. "Rose had been hibernating longer than anyone had anticipated. Like one of those wild animals that once existed, she turned on her sensors every few hours just to check that nothing was wrong, and keep sleeping..."
- The girl of my dreams *(La noia dels meus somnis*) by Juncal Barbosa. "The keys were still jingling when Paul asked Sandy to turn on the lights. It was time to take off your shoes, have a glass of wine. Sandy had warmed the house. When the sun went down, she turned on the heater. Sandy..."

The winners have published their stories in The Chemists News "*Notícies per a Químics, NPQ*" from the Official College of Chemists of Catalonia [15]. You can visit this magazine [16], in Catalan language. Fig. 5 shows the short story presented by the authors at the same contest. We hope you are tolerant with our story.

The time travel has never been demonstrated. However there are some scientific theories that argue that time travel is possible.

"The magic travel

In the scenery there is a human-size box, all made of wood carefully decorated.

- The old woman chooses one volunteer.

- The volunteer is a young tall man. He would enter inside the box, but before he does, the magician asks him to show his watch.

- It is turning midnight. The man is now inside the box...

- Suddenly a strange sound comes from inside the box. The man is screaming.

- The old woman looks worried, she hurries to open the door, but she can.

- The man continues screaming...everybody is frightened...

What is happening?...and

- Suddenly the man stops to screaming.

- Immediately, the old woman tries again to open the door and now it opens smoothly.

For the public surprise, the man is not inside... He appears on the opposite part of the scenery, looking disoriented. He is wearing his pyjama.

- The old woman smiles and asks the man to show again his clock: it is now turning four o'clock in the morning."

Figure 5. A short science fiction story written by the authors

4. Results and Discussion

Science is not just knowledge, It is also a persevering curiosity, an element of systematic doubt and the openness of mind. Do we need to talk about the principles of scientific reasoning? Yes, certainly we have to do, and the scientific diffusion is necessary to obtain good results.

In Catalonia, the golden age of the scientific dissemination was at the end of last century (1984-1995). There was several scientific supplements on the newspapers promoted by

Vladimir de Semir [17], as in La Vanguardia. Also Jorge Wagensberg [18], Barcelona Museum of Science director, did a lot of activities to disseminate science. Now, in COVID-19 conditions, science diffusion needs help from all educative instances. We hope that our activities could promote science between students and society.

Fig. 6 shows "The Color of Science". Jorge Wagensberg composed this exposition at the National Museum of Science and Technology of Catalonia.

Figure 6. The color exhition at the Barcelona Museum of Science

The exhibition reflected on the role of science and technology in our society, through scientific-themed illustrations by cartoonist Fernando Krahn, which highlight the possibilities that humor has as a teaching tool. In addition, the illustrations are accompanied by poems written by David Jou, professor of physics at the University and poet. As we said inicially, science is not just knowledge and it could be related with arts.

Activities presented in this article allow us to explain chemistry and science fiction but, above all, show how they are applied at the moment or how they could be applied in the future, all in our real life. Robots and space voyages are real and present in our daily lives.

The impact of this new approach to the science in COVID-19 circumstances has been considered as a valuable experience between students and teachers. Their feedback reveals that most of the students want to do again this activity in the future.

Some students´ opinions are:

"The aim of this activity is to form conflicting opinions about science"

"Climatic, technical and industrial conflicts appeared in my science fiction book"

"Conspiracy theories and distrust of science and business are present in science fiction"

keeping all of this in mind, students understood that is essential have a good background and knowledge on science when dilemmas and conflicts arise.

Finally, the evaluation of these activities by participants, teachers and students, was very good and outstanding. Theachers observed a significant increase in students`s participation and motivation about working on chemistry and science fiction.

Students considered these activities during COVID-19 course as a valuable and helpful experience. They also greatly appreciated the possibility to find out Isaac Asimov and the opportunity to increase their knowledge of chemistry, science and science fiction.

5. Acknowledgements

We would thank all participants, secondary school students and their teachers and our university students for their important inputs and fundamental cooperation.

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The Role of Synchronous Tools in Online Learning Practices after the Pandemics

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Abstract. The Covid-19 pandemics had most impact on face-to-face education, but online learning was not immune to the changes in all our lives caused by the situation. Imposed lockdown led to greater use of and familiarization with web conferencing technologies, potentially intensifying and driving new ways to learn and communicate in the context of distance education. In this paper we report on a survey on master's students perceptions of the use of synchronous tools in a distance teaching university, before and during the pandemics. The results indicate that students are more comfortable with tools like Zoom, and that they help them to better relate with teachers and classmates, improving their learning.

Keywords. Distance and Online Learning, Synchronous Activities, Web Conference, Lockdown, Collaborative Learning.

1. Introduction

The change in all our lives due to the lockdowns imposed by the COVID-19 pandemics has also impacted on the processes of teaching and learning. Face-to-face universities had to alter their practices, mainly by conducting online classes and subjecting students to online exams, thus trying to replicate in the web environment the presential methodologies they were used to. For various reasons, this replication is not ideal, and they are now adopting strategies typical of tried-and-true distance and online teaching and learning [1-3].

Distance teaching universities, though to a lesser extent, also had to adapt some of their practices. For instance, the portuguese Open University (UAb) moved all its exams online. Other, more subtle (or not officially decreted), differences occurred, in the behaviour of teachers and students.

In UAb, master's degree in Food Consumption Sciences (MCCA) and master's degree in Web Technologies and Systems (MW) have a duration of 2 academic years. The first year consists of several courses, with different thematics that prepare the student to do a dissertation. In both masters there are compulsory and optional courses, allowing students the opportunity to choose the aspects and themes of most interest to them for their future research. These courses are taught through distance education, with e-learning strategies.

The methodology used follows the pedagogical model adopted by Universidade Aberta [4]. The platform used to support learning activities is the Moodle Learning Management System, and the courses are mostly delivered in Portuguese, with some materials in English.

At the master's level, the Zoom web conferencing platform is sometimes used to discuss themes, presentations and discussion of assignments done by students, as well as to establish contact with other stakeholders and researchers.

In this paper we conducted a survey on the behaviour of students regarding the use and adoption of synchronous tools, such as web conference. We asked students of the two masters' programs (Computer Science and Food Consumption Sciences) their opinions on whether and why their use of web conference has increased and/or improved. Our main goal was to study if more technically trained students such as the ones from Computer Science made greater use of these technologies, compared to the Food Consumption students and the differences behaviours after pandemic situation (1 year and 6 months after Covid19 began).

2. Methodology

We conducted an online survey with LimeSurvey, targeted at two classes of masters' students, both from Computer Science and from Food Consumption Sciences.

The survey started with some questions to characterize the responders:

- Masters program
- Age
- Place of residence
- Have you started to work at home after Covid-19 restrictions began?
- Are there more adult persons working at your home?
- Are there underage persons working at your home?

The bulk of the survey took the form of a series of statements that responders should mark in a 5-point Likert scale, from “completely agree” to “completely disagree”. Two groups of statements were posed, for the situation before the pandemics, and the situation afterwards.

Before the pandemics:

1. I felt that my study program was less accepted than masters' programs from public face-to-face universities.
2. I felt that distance education was underrecognized.
3. I felt uncomfortable with the technology of web conference services such as Zoom.
4. I felt uncomfortable using web conference services such as Zoom, from a social point of view.
5. I appreciated that teachers would promote web conferences, even when they are not planned in the learning contract.
6. I participated in few web conferences during my masters' degree.
7. I created few connections to my teachers, because communication was asynchronous.
8. I had difficulty working with my classmates, because we didn't use web conference tools.
9. In my opinion, distance teaching should be totally asynchronous.

During the pandemics (1 year and 6 months after Covid19 began):

1. I feel that my study program has more acceptance because other universities also had to do online teaching.
2. I feel that distance education became more known and valued.
3. I feel more comfortable with the technology of web conference services such as Zoom.
4. I feel more comfortable using web conference services such as Zoom, from a social point of view.
5. I appreciate more that teachers promote web conferences, even when they are not planned in the learning contract.
6. I participate more in synchronous activities in the masters program, because they use web conference.
7. I created more connection to my teachers, since we talk more in a synchronous way.
8. I work and communicate easier with classmates, through web conference tools.
9. In my opinion, distance teaching should become completely synchronous.

The program used to treat data was STATISTIC We applied Spearman rank order correlations (R) between the responses to the 18 statements of the survey and features: masters program, age of students, living in Portugal versus abroad, change to work at home (yes or no) and have more persons at home. The significance level was placed at $p < 0,05$. In the results we only considered the significative correlations.

3. Results

3.1. Characterization of the sample

Our survey sample had a size of 20 students, 10 from each masters program. The following graphics show distribution of the students in the sample according to age (Fig. 1), workplace and co-habitation with other working persons (Fig. 2 and 3). The majority of students (60%) are under 40 years old, and half of them worked at home during the pandemics. Only 30% of the students had other adults working at home. Only one of the students mentioned having underage persons working at home, so this factor was not considered in the results analysis.

Concerning statement 3, there was significant difference between answers depending on the master's degree they are attending ($R= 0,491354$ and $p=0,027795$). The graph can be seen in figure 10.

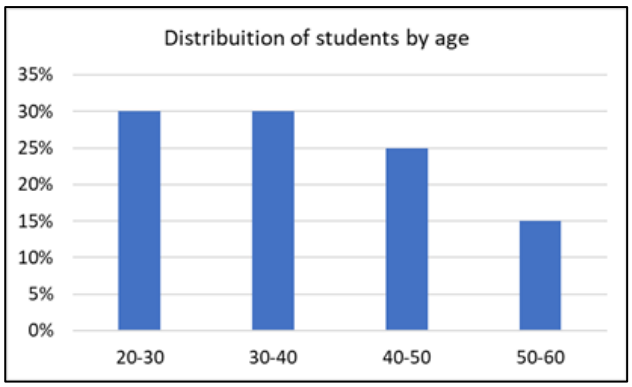

Figure 1. Students' ages

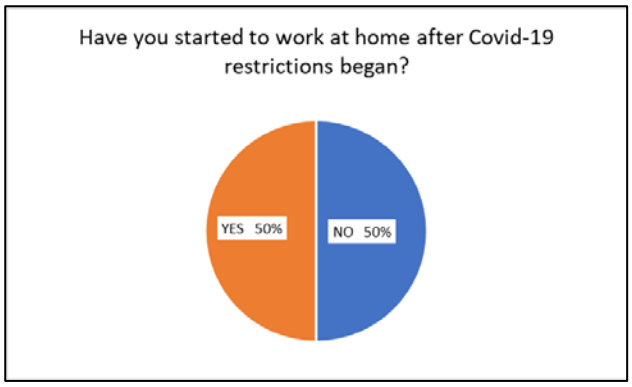

Figure 2. Workplace after pandemic lockdown

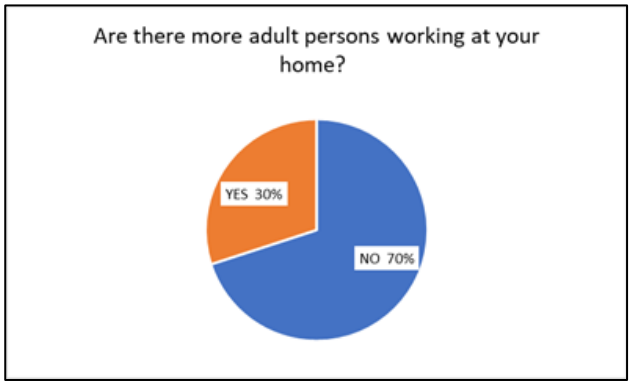

Figure 3. Other adults working at home

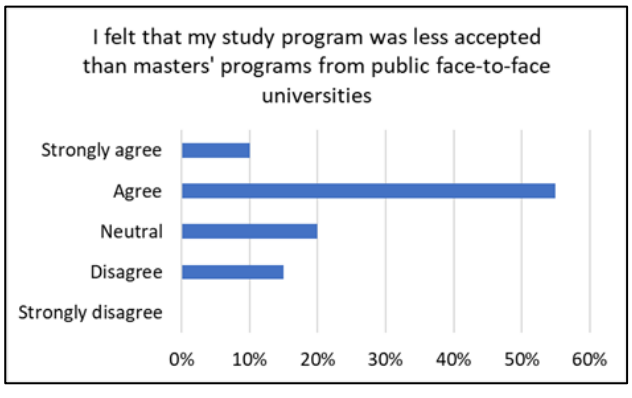

Figure 4. Results obtain to statement 1

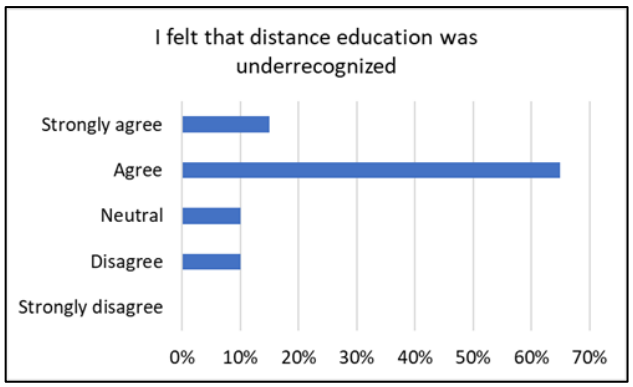

Figure 5. Results obtain to statement 2

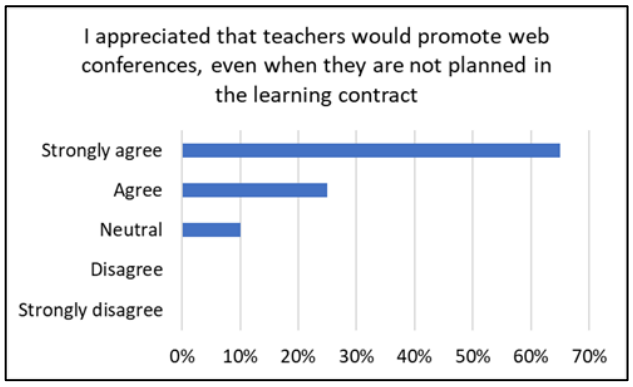

Figure 6. Results obtain to statement 5

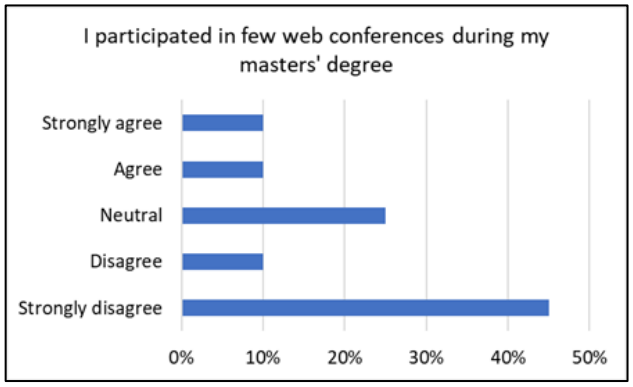

Figure 7. Results obtain to statement 6

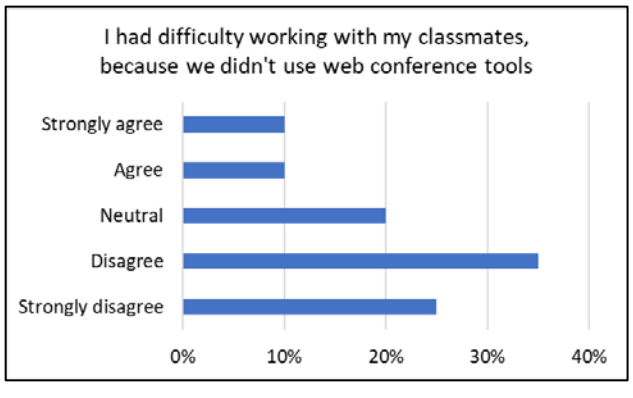

Figure 8. Results obtain to statement 8

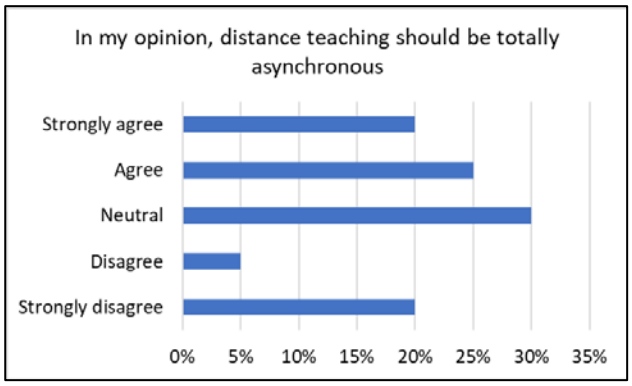

Figure 9. Results obtain to statement 9

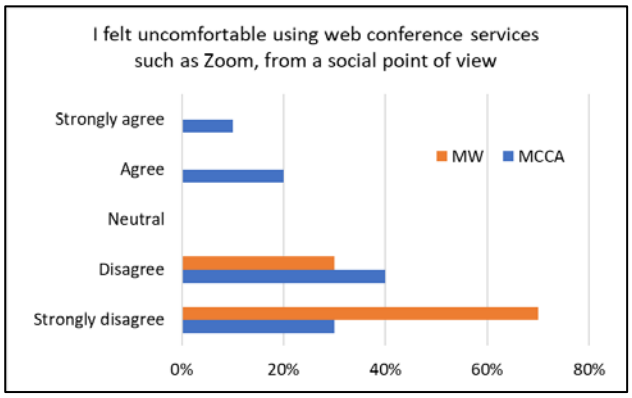

Figure 10. Results obtain to statement 3

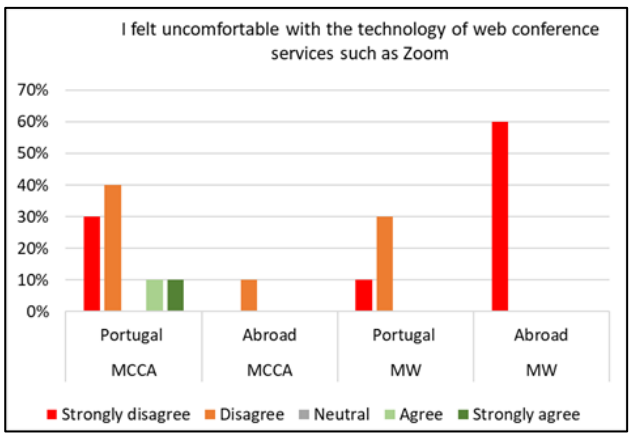

Figure 11. Results obtain to statement 4

Statement 4 also had significant difference between answers depending on the master's degree they are attending (R=0,465507 and p=0,038601) and localization in Portugal or abroad (R=-0,527819 and p=0,016759). The graph can be seen in figure 11.

Statement 7 had significant difference between answers depending on where they live: Portugal or abroad (R= 0,469183 and p=0,036892). The graph can be seen in figure 12.

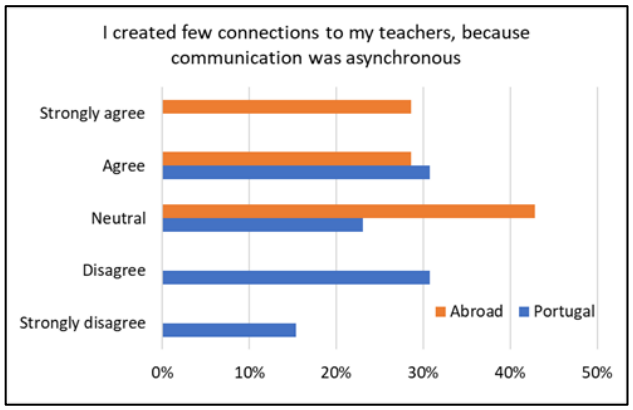

Figure 12. Results obtain to statement 7

3.2. After the pandemics

The results of statements where is no correlation found can be seen in figures 13 to 20.

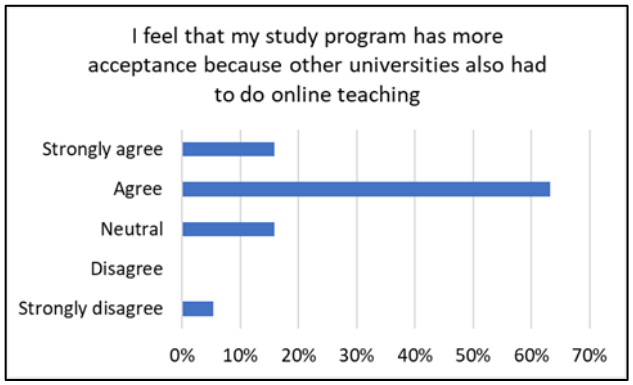

Figure 13. Results obtain to statement 10

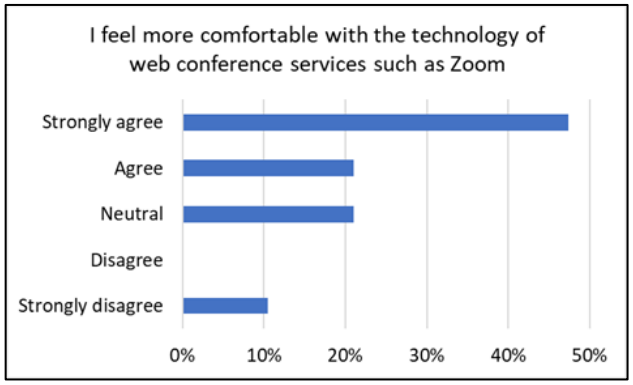

Figure 14. Results obtain to statement 12

Statement 11 had significant difference between answers depending on the master's degree they are attending (R= 0,520354 and p=0,022372). The graph can be seen in figure 21.

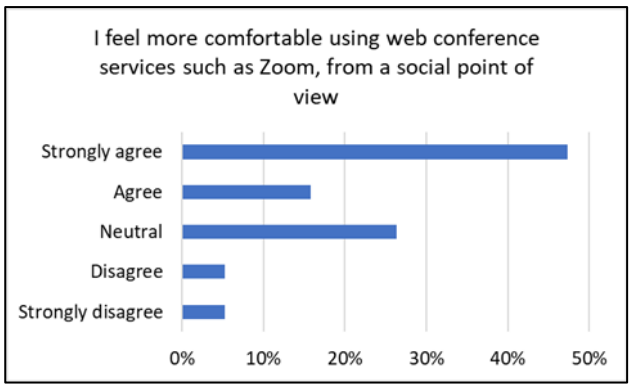

Figure 15. Results obtain to statement 13

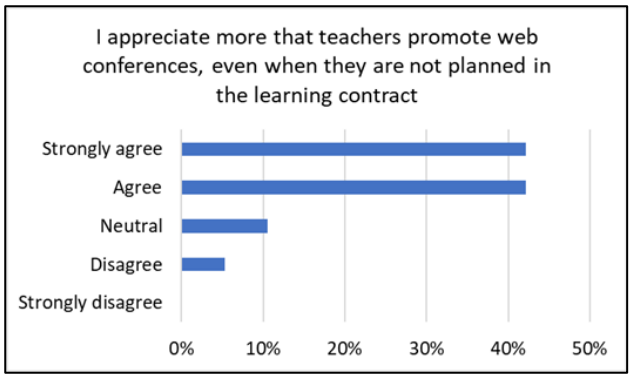

Figure 16. Results obtain to statement 14

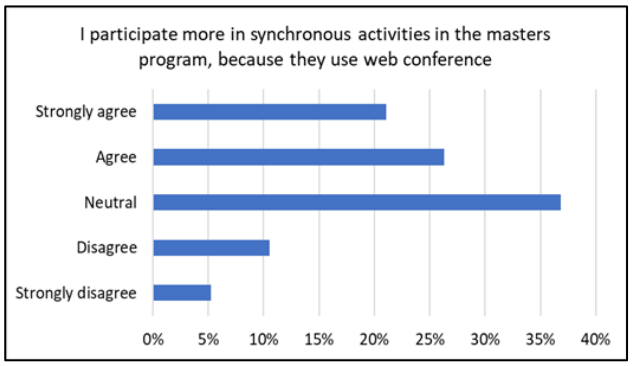

Figure 17. Results obtain to statement 15

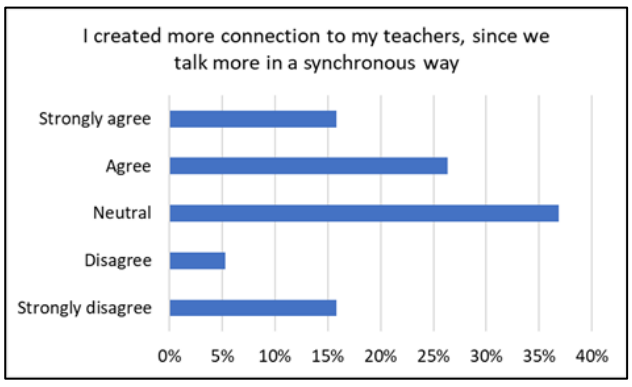

Figure 18. Results obtain to statement 16

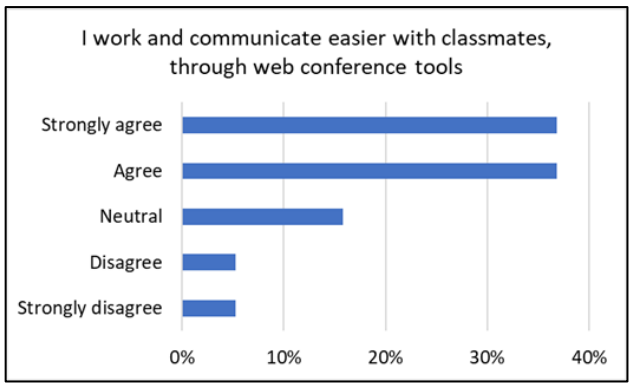

Figure 19. Results obtain to statement 17

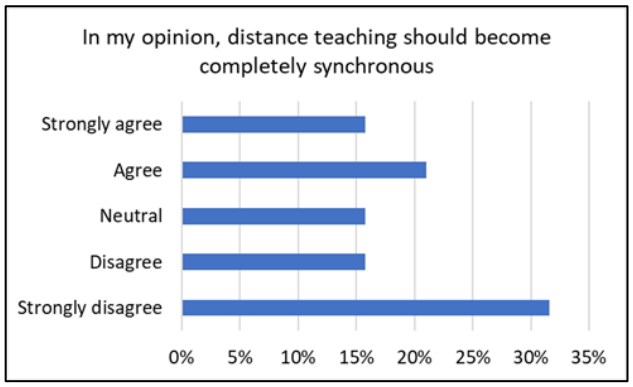

Figure 20. Results obtain to statement 18

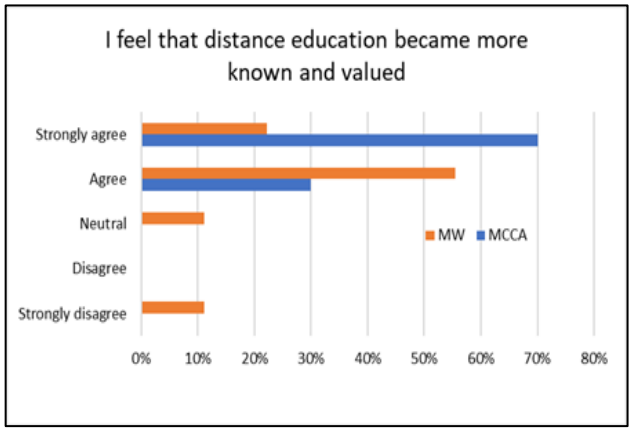

Figure 21. Results obtain to statement 11

4. Discussion and final remarks

The results show that students feel that distance education is more recognized and accepted because of the pandemics – distance methodologies had to be applied to some degree in all levels of education, but also the realization that quality distance learning, demanding proper training and specialization, legitimizes open universities to better provide this kind of education.

Not surprisingly, students from computer science feel more comfortable with synchronous technology, while students from food consumption sciences got necessarily more used to it during the lockdown. Also, students from abroad feel more comfortable with synchronous technology, which can be explained by having to resort more often to videoconferencing tools to communicate with their contacts in Portugal.

As for the online teaching and learning model, most students agree that a completely synchronous model is not suitable, rather benefitting from a combination of synchronous and asynchronous activities. But, since many students worked at home, it is not clear whether, when resuming normal work routines after the pandemics, synchronous activities will be more difficult to attend.

One thing seems clear: more familiarity with videoconferencing tools (both technically and socially) allowed students to develop new learning and communication skills that undoubtedly changes the way they relate to their distance education teachers and classmates, ultimately improving their learning process. Further research is needed to confirm the impact of these more synchronous approaches on academic results, and across other fields of study.

In summary, we found out that synchronous tools have a role in online distance education, especially at post-graduate levels, where students need a more individual support. With the pandemics, the importance of this approach became apparent, as students became more comfortable with the technology and realized that it contributed to increase their proximity to teachers and classmates.

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Down to Earth – Literally! Teaching Soil

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Abstract. The paper outlines the importance of soil as a virtually non-renewable resource and how we should appreciate its importance. Soil is rarely taught in schools and even more rarely is it used for scientific investigations. Methods for teaching soil at all levels from early years through to sixth form and teachers are given with ideas for investigations and practical work at all levels. The need to conserve soil by halting erosive practices is outlined and suggestions for further discussions made. Ways of integrating soil topics into other subject areas are suggested.

Keywords. Soil, Teaching, Investigations, Integrated Topic.

1. Introduction

One of the most important of all our planet's resources is soil, and yet the topic generally receives little attention in school curricula. True it features in the English primary science curriculum but few teachers give it much time: usually soil is mentioned and the appropriate box ticked without any real discussion.

Without soil, where would be? There would be little vegetation, hence no food for herbivores and so no food for the carnivores. Would we be reliant on food from the sea? There would be no trees – forests or woods with the numerous plants used medicinally; no wood for building shelter or sailing ships. Soil is vital to our survival as a species.

Teaching and learning about soil is not just confined to 'science' but is easily integrated into other subject areas (history, literature, religion etc) with some thought. It also links together the main science subjects at higher levels.

Soil takes hundreds of years to form and as such we must use it carefully. We need to protect it from degradation and erosion. Most of all if we understand how fragile it is then we can care for it and it will reward us with crops we can eat and use. One way of understanding Soil is to learn about it at an early age. Soil lessons can be interesting, fun and informative for any age, and we can all improve our use of it by better understanding.

Soil is not unclean although many children will call it 'dirty'. However, with all soil work it is important to wash one's hands and scrub nails thoroughly to ensure they are clean after playing in it or using it. The use of thin gloves may be advisable for a few children (or adults) with sensitive skins.

Soil is a mixture with a basic composition of 25% air, 25% moisture,45% inorganic (mineral) particles, 5% organic (humus) particles plus soil animals. This varies widely depending on climate, latitude and rock type.

2. Teaching Soil to Early Years (those under 5 years)

Let's start by looking at Soil with Early Years children - that is those under age five. At this age in England they may call this material 'dirt' (or perhaps mud when it is wet) and enjoy playing with it [1]. All children will have a name for it. Just feeling it and allowing dry soil to run through their fingers is interesting and can elicit a wide range of vocabulary. Rubbing soils in the palm of one's hand enables one to feel the texture – children will recognise a sandy feel, or a silky feel. If the soil contains a lot of clay then they can form balls, sausages and rings from a handful of soil.

When investigating a soil more closely, young children will discover many little creatures living in it; a morning spent looking for worms, woodlice, ants and mini beetles and tiny spiders is just what they enjoy. A spade full of soil placed on a tray watched carefully can provide interest for quite a while. Children will talk about what they can see and perhaps learn to identify some of the different creatures.

Figure 1. Examining Solis

Finger painting with wet soils can produce a range of different colours, from yellowy orange to dark brown/black which surprises many adults. Planting seeds and watching them grow is exciting especially if you make your own newspaper plant pots. Make sure you use quick growing seeds otherwise the 'wow' factor is lost… most seeds need at least a week to germinate!

Figure 2. A Wormery in a jar

It is quite simple to make a wormery in a large glass jar and watching how quickly the worms mix up the materials is amazing! A large clear coffee jar is suitable for a small scale wormery but use anything that is transparent so that one can see the activity. Add different layers to your jar – fine fish gravel at the base perhaps, sand, garden soil, some darker organic material (often called 'peat') topped off with some dead leaf material. This does need some water to dampen it all, then add a couple of worms. Don't let the jar dry out! The worms will mix up the contents and children can watch their progress daily through the glass sides of the jar. The mixing can then be related to what happens in the garden and used to explain why worms are so important for a good soil.

3. Teaching Junior Children (age 6 to 10)

Lower Junior children can begin to look at soil more scientifically. These are children aged 6-8 years [2].

As with any subject, it is advisable to find out what the children know about soil before embarking on the topic to establish their degree of knowledge and identify any alternative ideas. The word 'bacteria' chills many hearts these days, the idea of there being 'good' bacteria (as well as bad) seems to have got lost! Compilations of what a class initially know about soil are useful to return to after soil lessons, to see what they have learnt, and may be used for basic assessment procedures. Bubble diagrams can be used for this purpose. Draw the bubble on a board and ask children to tell you everything they know about soil. Write it around the bubble in one colour. At the end of the lessons ask them again and complete the bubble writing in a different colour so you can see what has been learnt

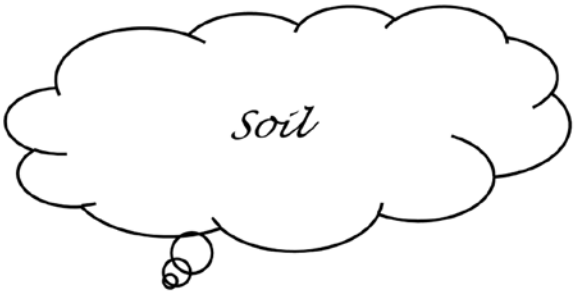

Figure 3. Soil Bubble

Concept cartoons are a way of getting children to start thinking about an issue by giving them pictures or statements which can spark discussion. Some of the ideas suggested may be totally irrelevant. One such is given here or you can draw your own. Children review the statements and come up with their

own ideas which can be talked through by the whole class.

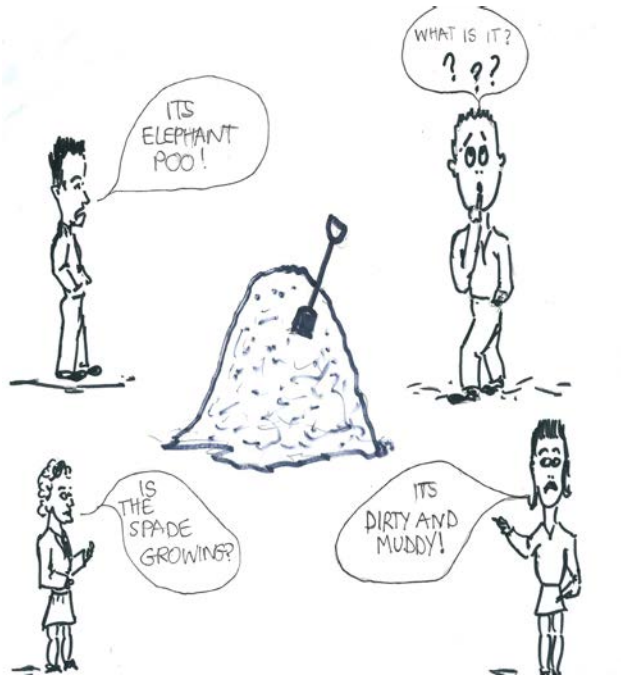

Figure 4. A Concept Cartoon [3]

After initial discussions about soil e.g. what it is and what it is used for, I tell the children a cartoon story of how soil forms. I draw each section on a white board and get the class to help me build up the soil pictures as it develops. This method introduces new words associated with soil and by repeating words as the cartoon is drawn, the children begin to appreciate the makeup of a soil profile.

Figure 5. The Soil Story Cartoon [3]

4. Practical Investigations with Junior Children 6-8 years

Now is the time for some practical investigation [3]. Once children have an idea of soil formation they can, with a little help, come up with their own ideas of what can be done to find out more about soil. Class discussion usually elicits several suggestions: soil moisture content, soil composition and soil permeability, though not using that terminology!

- Find how much moisture is in your soil.
- Examine the components of your soil
- Compare the permeability of your soil with another
- (Discover the pH of your soil age 9-11)

Figure 6. Possible investigations at Junior Level

For any soil investigations do try, If possible, to have three different soils. Get other staff to bring a bucket of soil from their gardens. Different soils can be made by adding sand or purchased organic content in specific ratios to just one soil, to give three variations – for example: the original, the original plus sand, and the original plus organic content. You will need quite a lot of soil!

The amount of water contained by soils is often considered and can be found by weighing a soil, then drying it out in an oven on a low heat, or even leaving it in a warm dry classroom for a few days before reweighing and calculating weight loss – here is some maths integration! A soil should contain up to 25% of its weight in water. Calculating moisture content of soil:

- Weigh soil and record weight (W1)
- Dry soil
- Reweigh soil (W2)
- Calculate percentage moisture in soil

(W1-W2 divided by W1, multiplied by 100)

Record your results. How close is this to the expected 25% moisture content? Why is this soil wetter or drier than another? Will this affect the vegetation that can grow on it?

The next suggestion frequently identified by the children could be to investigate soil composition. Sieving is a fun way of finding the different materials within the soil and different sized particles. Expensive equipment is not needed either. Various pieces of kitchen equipment can be used as sieves. Examples are colanders, sieves used in deep frying pans, cake cooling trays, sink tidies (I have metal ones that stand in my sinks which are really useful!) and of course, flour sieves. Children need to record the order in which they use the sieves, starting with the sieve with largest holes first, and ensuring they have a bowl at the bottom to catch the residue.

It is important that young primary groups understand the idea of fair testing – in other words that they need to do exactly the same thing for each investigation (not that everyone can have a turn!). For example, when sieving different soils, they must use the same amount of soil each time.

It is not necessary to actually weigh soils with younger children though it really is desirable but using the same number of spoons-full or cups-full each time is important. With children aged 7 upwards weighing is important and another scientific skill. 400g of soil is best used, as this gives a range of weight in each sieve. If children are working in groups, one child needs to record the amount of soil in each sieve for each soil. Comparisons can be made between soils – graphs drawn and ideas about differences discussed (Maths input again) This exercise is great fun carried out in the open, where it doesn't matter if soil gets spilt everywhere but it can easily be swept up if the investigation is undertaken indoors.

Figure 7. Sieving

Finding permeability – the rate at which water flows through a soil - is a good investigation too. Again you don't need expensive equipment. Small drinks bottles can be used. Carefully cut off the top section to make a funnel, which can sit in the remainder of the bottle as in the diagram. Proper filter papers are a real luxury but coffee filters work just as well, or even fine weave muslin circles which can be washed and reused. Ensure a 'fair test' is maintained by using the same amount of soil put into the filter/funnel. Have a stopwatch handy. Pour a known amount of water onto the soil and time how long it takes to drip through completely. Water can be measured by a plastic cupful.

If three different soils are used, use three different investigations, recording the time taken for each soil to allow water to pass through. The time taken needs to be recorded and the volume of water which passes through the soil can be compared in the bottom of the bottles. All these points are using basic scientific skills of observation, and recording. Ask the children to explain the differences and they will come up with a range of ideas which can be discussed.

- Use about 400g known weight, including litter
- Sieve through 3 or 4 sieves (can be garden sieve, colander, flour sieve and bowl to catch very fine particles
- Weigh what collects in each sieve. Work out percentage
- Should have litter, then small pebbles, roots, then finer material, finally silky very fine particles
- Compare different soil percentages

Figure 8. To find soil components by sieving

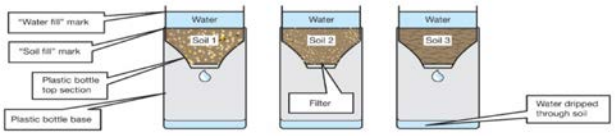

Figure 9. Soil permeability investigation. Diagram from Earth Science Education (Unit primary disc)

Figure 10. Permeability investigation

I generally introduce the idea of soil horizons through the soil story but can rarely show them to children in the field. However, one class of primary children were amazed at the clay we found only about 30cms down, which could be made into rings and balls as it was so dense.

I use a puzzle for primary children to work on to instil the idea of layers (horizons) and get them to use the correct terminology - which they sometimes remember from the soil cartoon. We also draw litter bugs, see below, using the outline of leaves to turn into bugs. And sometimes the children make soil cocktails – using different breakfast cereals and sweets placed in a transparent glass or beaker, worms are usually liquorice tubes….

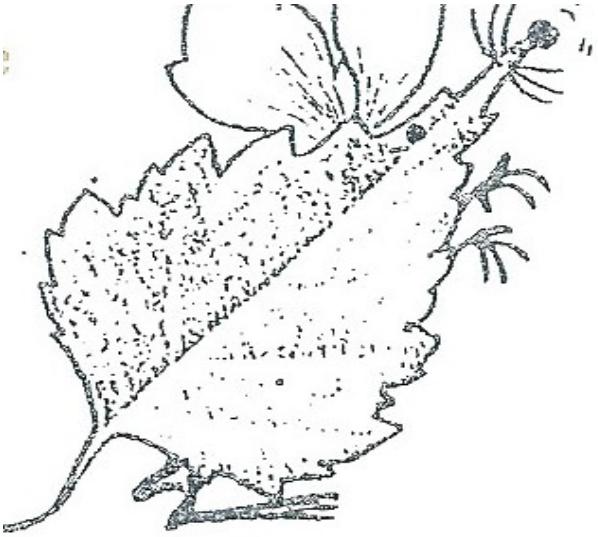

Figure 12. A litter bug drawn from a leaf outline

5. More Advanced Soil Teaching

The amount of theoretical input you give will depend on the age group of your class. And whilst the earlier investigations seem to be a primary activity, they work equally well at secondary and post sixteen levels where the students would first hypothesise which soil will be least/most permeable once they have found the content through sieving.

The soil profile is a difficult concept for both primary and secondary young people. A soil profile shows different layers within the soil. The layers are termed 'horizons'. By carefully digging a deep hole about 50cms square, one can see the layers, which should be removed and saved so they can be replaced. Using a soil corer will also show the different layers and is much easier – if you have access to a corer. However, it is also possible to see the different horizons along the edge of a river, or in a road cutting – or even a hole that workmen have dug.

Figure 13. Soil profile and horizons

At senior levels one can delve into the properties of the soil, the kinds of nutrients and minerals that will enhance vegetation growth. The acidity or pH or the soil can be measured – and the range of natural vegetation that will form on specific underlying rock types. [5] Different rocks and hence different vegetation will cause the soil to be either acid or alkaline. To test for the pH of a soil (the alkalinity) use water that has passed through the soil – perhaps saved from the permability investigation. Soil pH colours – the chart below shows the range of colours that may be found – oranges are acid to greens/purples are alkaline. Around pH 7 is neutral.

- Test the water in the beaker with a pH indicator to find the pH (acidity or alkalinity) of each soil
- Colours range from orange – very acid ph5 , through neutral pale green, to purple, very alkaline pH14

Figure 14. Soil acidity or alkalinity (pH) (older children)

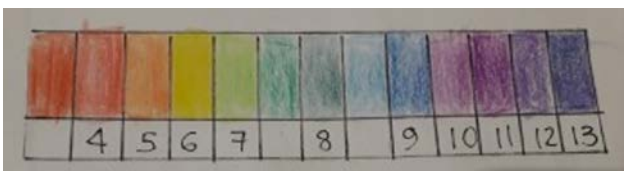

Figure 15. pH test colours

6. Further work at Senior Level

Climatic conditions are important in soil formation and a world map of physical features and climatic conditions can be a discussion base for where soils might develop [5]. It is important to stress that whilst one can hypothesise on areas where soils will form this must be followed up by actual fieldwork to ascertain the soil's properties. Otherwise disastrous effects can occur, an example of which is the British Government's groundnut scheme in 1947. It was deemed possible to grow groundnuts in Tanzania to boost the British and Tanzanian economies but soil and climatic conditions were not taken into account and some £36million had to be written off by 1953. There are of course probably other more local examples that teachers can use. Discussion of results and pulling together all the information accrued is an important part of the learning process. Small discussion groups work well, coming up with findings to specific questions which can then be debated with the whole class. Points to raise are:

- How do the soils vary
- Why do they vary
- Does the moisture content vary. Does the size and ratio of the particles relate to the moisture content?
- What is the underlying rock
- What is the local vegetation, and how does it affect the soil?
- Try to link these to your soil formation

7. Soil Degradation

Research followed by class discussion about deforestation which causes initially soil erosion, leading to horrific landslides and mudslides as in Malaysia and the Philippines with great loss of life is a way of looking at issues surrounding soil degradation [5]. Agricultural clearance of trees for subsistence agriculture or cattle ranching causes more soil degradation (soil degradation being the physical, chemical and biological decline of soil quality). Websites offer many examples which can be researched at higher levels and used to highlight the importance of soil as a resource.

8. Conclusions

Soils cover a wide range of science areas. They offer simple and easy investigative opportunities for all levels using numerous scientific skills. They relate to everyday life and are an easily available resource. Finally soil investigations are activities that all children can participate in at all levels.

Also, these topics can be integrated with

- literature – (the Grapes of Wrath)
- religion – the importance of the annual flooding of the Nile bringing fertile silt down river.
- history – the movement and settlement of peoples and animals to areas of fertile soils all show the importance of this amazing material that we so take for granted.
- environment - the present destruction of soil and its subsequent loss through deforestation is an important social issue.

Working with soil is for all ages at all levels. It is a topic that can be used not only in science but to link environmental, social and economic issues which have become very important in our present day world. It is therefore, in my opinion, vital that we all understand how precious a resource soil is.

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The Sea Starts Here. A Sucess Case in Sines (Portugal)

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Abstract. The campaign "The Sea Starts Here", designed by "Eco-escolas", is raising awareness on the impact of littering into road gutter (that might lead the litter into the sea), in order to prevent it. Sines municipally adapted the methodology and added an extra activity: cleaning the road gutters in the schools of Sines and its surroundings. So, several activities were carried out: workshops, cleaning of the road gutters, conception and design of the pictures in the classroom, plus draw and painting the design in the road gutters. The whole project was extraordinarily successful, and all the activities had clearly upbeat reactions from the students of the 7th year. The spoken feedback from the school community, was also incredibly positive.

Keywords. Marine Litter, Ocean, Pollution, Marine Literacy.

1. Introduction

1.1. Contextualization

The Sustainable Development Goals, adopted by all the United Nations Member States in 2015 [1], underscore the worldwide concern with the importance of ensuring sustainable production and consumption patterns, as well as achieving environmentally concerns on waste management throughout its entire cycle of life. In that regard, Environmental Education Projects (EE) that encourage the practice of "Rs" including prevention, reduction, reuse, recycling and separation at source, gain relevance.

As schools are privileged locations for raising environmental awareness, the "Environmental Education Program" (PEA) of the Sines Municipality, is focused on the the adoption of practices that value and protect nature and the environment. In this assumption, promoting skills, attitudes and behaviors that allow observing, questioning, evaluating and acting constructively in the natural environment, is the main challenge.

1.2. Road gutters – marine pollution

Marine litter, and especially the accumulation of plastic waste, has been identified as one of the biggest global problems of our time, causing a wide range of adverse impacts, such as ecological, aesthetic, economic and socio environmental.

In fact, nowadays the marine litter is out of hand, and many coastal countries are extremely alarmed about it. A study [2] mentioned that about 69% of the litter found in the shoreline of Chile, is mainly littering by beachgoers, or carried from streets, drains and gutters.

The problem of beaches pollution and marine environment contamination by plastics originating from road gutters, is mentioned since the last century (i.e., [3]).

Other important sources of coastal pollution are the cigarette butts. It is important that the messages in anti-cigarette-litter campaigns, emphasize that cigarette butts are not just litter but also toxic waste which can be very harmful if it is improperly disposed of [4], such as dropped on road or placed directly in the gutter.

1.3. Sines Municipality

The location of Sines city can be seen in figure 1. The municipality of Sines belongs to the district of Setúbal, has an extension of about 203.3 km^2 and includes two parishes: Sines and Porto Covo.

From the natural point of view, it is a privileged territory. To the south, it integrates the "Southwest Alentejo and Vicentine Coast Natural Park" (PNSACV) and, at its northern limit, the "Santo André and Sancha Lagoons Natural Reserve" (RNLSS), areas of the "Natura 2000 Network", reserved for the conservation of important natural values of the fauna and flora.

Sines is a center of regional, national, and even global development, due to the dynamics introduced by the industry, supported by an important deep-water ocean port. In recent years, the city has grown very quickly, as a

result of the quality and size of its coastline.

However, the economic activities mentioned, also result in increased environmental pollution. The tourism, agriculture, and fishing sectors feel particularly threatened, and this has led to several manifestations of displeasure from the local community, over the years.

Figure 1. Location of Sines (adapted from google maps)

In this context, the various PEA of the municipality aims to continuously raise awareness, awakening eco-friendly habits and encourage a responsible and environmentally balanced behavior, in order to preserve and saving natural resources and the environment.

Addressing a set of themes and activities, with a focus on the waste theme, covering all the schools and levels, from pre-school to secondary education, is why the PEA presents itself as an important tool at the service of education. The objective is to provide the students with a set of critical knowledge and skills that allows them to act, directly and/or indirectly, in the construction of a better society and a cleaner and healthier environment.

1.4. Project Description "The Sea Starts Here"

The "The Sea Stars Here" is an international campaign, done in several cities and countries, namely in Barcelona (Spain) and Brighton (England), where a sensitizing phrase was inscribed near the road gutters as show in figure 2.

Figure 2. Barcelona and Brighton. Source: https://www.barcelona.cat/infobarcelona/en/tema/environment-and-sustainability/the-sea-starts-here-an-awareness-campaign-on-everyday-habits_1009375.html and The-sea-starts-here-dont-litter.jpg (600×400) (brightonenergy.org.uk)

The "Blue Flag Association of Europe" (ABAE) and its Eco-Schools Program in Portugal launched the project "The Sea Starts Here" (https://omarcomecaaqui.abae.pt/o-projeto/) (Fig. 3).

Figure 3. Organizers of the campaign in Portugal

The realization of this project requires a strict cooperation between schools and municipalities.

The project has 3 phases:

1 - Preparation: Each school needs to present one drawing/image proposal that they intend to reproduce in the gutters/sinks. The prototype image should include the relationship between the drawing and gutters/sinks, to scale.

2 - Development: The entire process of implementing the paintings must be supervised by the City Council.

3 - Communication: The school is required to send a photograph of the paintings made, through the Eco-Schools platform.

In Sines, the "The Sea Begins Here" project is part of the PEA for schools (started in 2019-2020), with the aim of raising awereness on the consequences, both in terrestrial and marine ecosystems, of the incorrect disposal of waste.

1.5. Goals of this activity

Since "*everything that is dropped on land ends up in the sea*", the main goals are:

- Alert to issues related to incorrect waste disposal and sea pollution;
- Raise awareness of the need to preserve ecosystems and biodiversity in general, and the quality of fresh and salty water in particular;
- Educate for active citizenship by encouraging young people to pass the message that "*everything that is dropped on land will end up at sea*";
- Promote a campaign with impact on the community;
- Stimulate young people's creativity through the development of different skills, namely in the areas of cooperation and plastic expression (arts).

2. Methodology

Although it started following the original campaign, the environmental education team of the municipality, adapted the objectives and phases of the project. It was development during the school year of 2019/2020, but the painting of the road gutters was only done in 2021, because of the COVID19 pandemic.

The Sines municipally developed an innovative methodology (Fig. 4) in which the students participate actively in the cleaning of the road gutters, helping the professional employees of the city council.

To evaluated if the goals of these activities were achieved, a survey was done to the students that painted the road gutters. A random sample group of students was selected to inquire (not all the students, because of the concerns with COVID19).

This survey was done presencially, through a questionnaire with several itens:

a) a group of questions to characterize the sample;
b) the evaluation of several activities performed;
c) the rates of the action.

A *Likert scale* [5] was used, rating from "not important" to "extremely important" and from "very bad" to "very good".

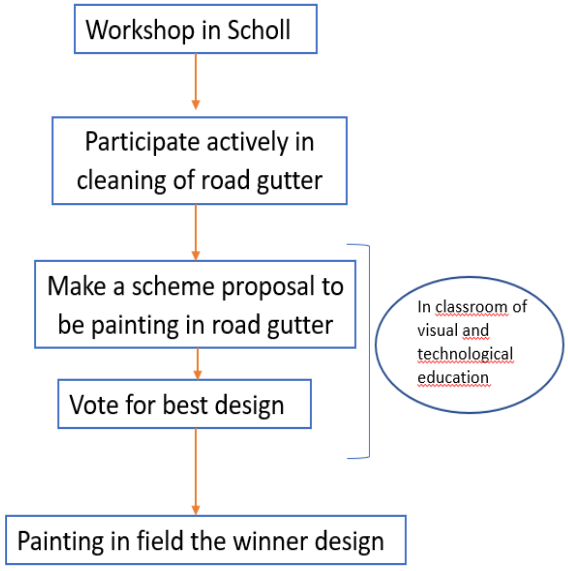

Figure 4. Methodology - sequences of activities

The survey was inserted in the program *LimeSurvey* and then exported to *Excel* where the tratament of the data was done.

3. Results and discussion

3.1. Students characterization

The students were aged between 15 and 18, with a mean of 16 years old, 89% male and 11% female. They were in the 7th grade at school, and, as it can noticed by their ages, some have failed some school year(s).

3.2. Importance of the theme

When questioned about the importance of the theme, almost 45% answered that its important, and none of the students disagree (Fig. 5).

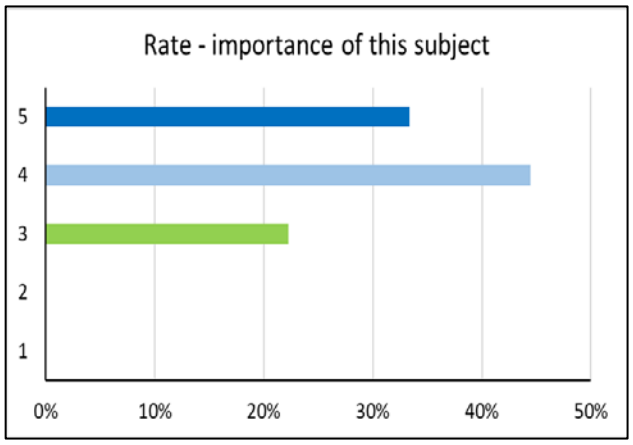

Figure 5. Evaluation made by the student about the importance of the theme. 1 is "not important" and 5 is "extremelly important"

3.3. Workshop

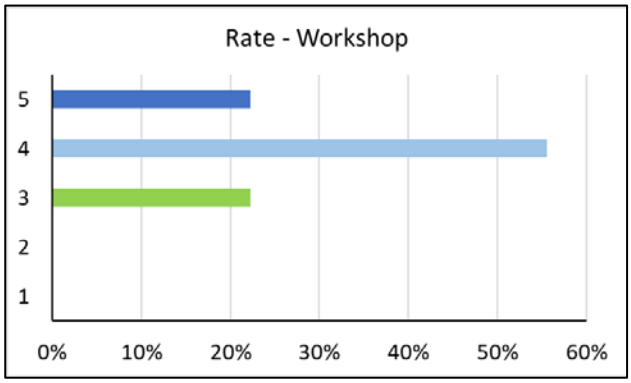

Figure 6. Evaluation made by the students about the workshop. 1 is "very bad" and 5 is "very good"

The initial workshop focused on:

- Explaining the problem of pollution and impacts of the marine litter in the ecosystems;
- The littering in the seawater that appears in the beaches;
- Raising awareness about plastic, cigarrete butts, etc., and the years that they take to degrade in nature;
- Identify the origins of marine litter;
- Learning how one can contribute to reduce the litter;
- The impacts of litter in road gutter, being its final destiny the sea, rivers or lagoons;
- Some problems that the litter causes along the trophic chains, can affecting the biodiversity;
- Presenting the project and the activities scheduled.

The students evaluated this workshop positively, as can be seen in figure 6.

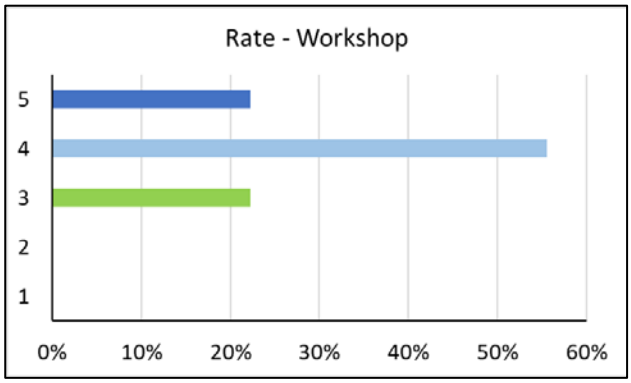

Figure 6. Evaluation made by the students about the workshop. 1 is "very bad" and 5 is "very good"

3.4. Cleaning of the road gutters

The participation of the the students in the cleaning of the road gutters, was done, as far as we know, only in Sines (see figure 7). When asked what they expect to find, 44% referred cigarrete butts, 22% mentioned cockroaches and others spoke of different things like spiders, rocks, masks used to COVID19 protection, juice packages, plastics, paper, etc.

Figure 7. Activity of cleaning the road gutters

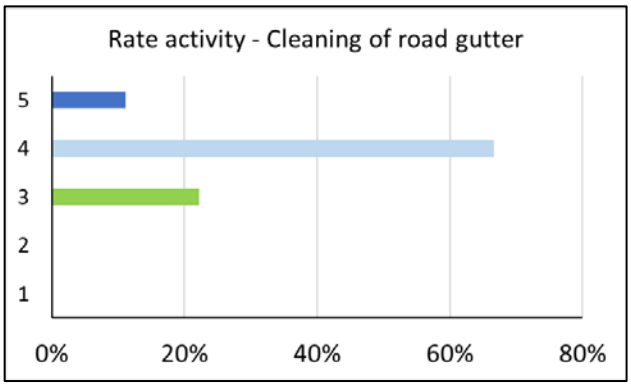

Figure 8. Evaluation of the activity – cleaning of the rood gutters

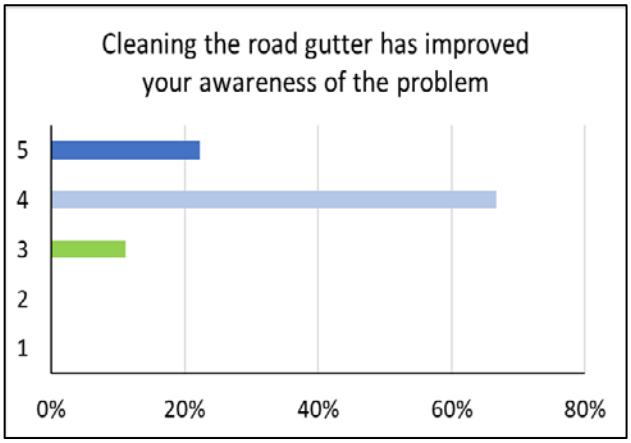

Figure 9. Evaluation about the improvement of awareness on problem

When asked if they expect to find what they ended up finding, 89% respond negatively and only 11% positively. This activity was well evaluated (Fig. 8) and improved their awareness on the problem (Fig. 9).

3.5. Scheme proposal made by the students

The students were asked about which colors they thought could better achieve the objective of visibility. They were given the possibility to chose more than one colour (Fig. 10).

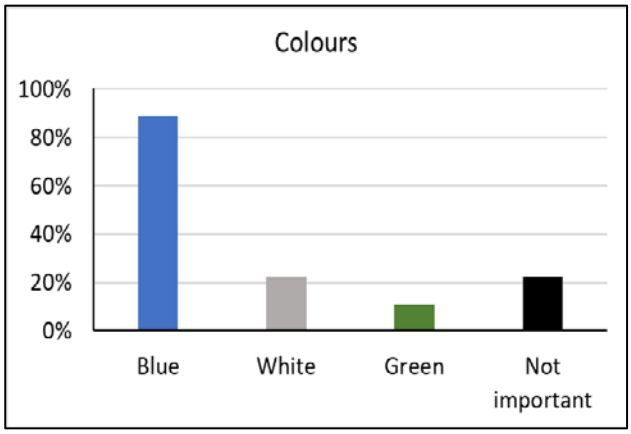

Figure 10. Colours that the students identify as best suited to paint the road gutters

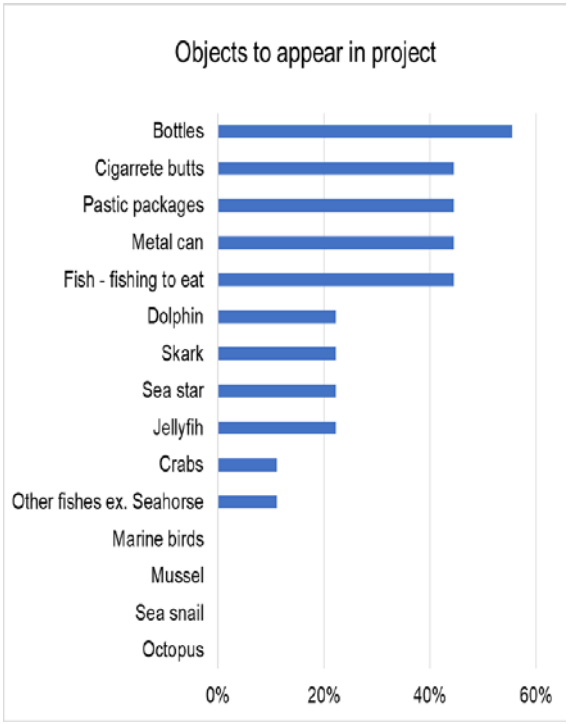

Figure 11. Images that students considered the most important to appear in the drawings, to arouse attention

The colour blue was chosen because it is normally identified with the sea and the colour white, as it reminds the sea foam. The green is the colour usually used in environmental activities, also being the "Eco-escolas" symbol (in Fig. 3). The drawings that students considered more relevant to arouse attention, represented litter objects, followed by images of marine animals (Fig. 11).

Concening of what should be painted in the road gutters, the answers were not consistent with what was done in the end. In figure 12 it can be seen a drawing done by students during this phase. Concerning the significance of the key sentence "The Sea Starts Here" and the drawings, the opinions of students are diverse, as can be seen in figure 13.

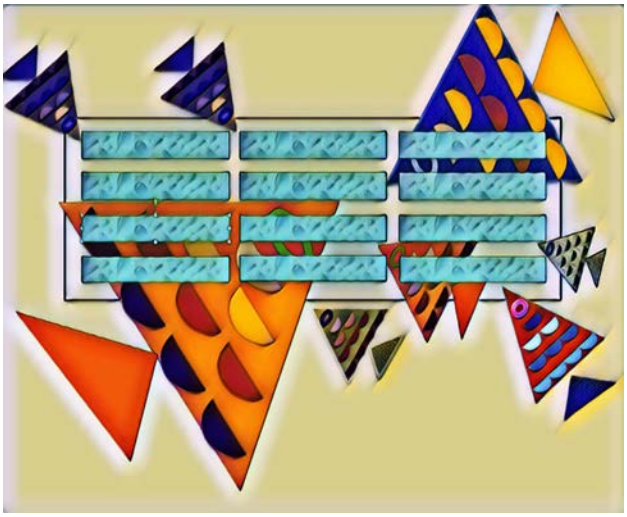

Figure 12. An example of what was done in the classroom in 2020

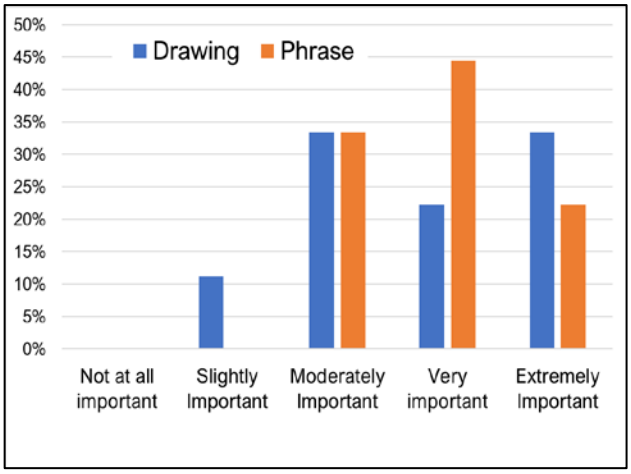

Figure 13. Significance of the key sentence and of the drawing to pass the message, according to the student's evaluation

3.6. Field painting

The winner projects were painted in the surrounding areas or including the road gutters, using special inks (not toxic), to avoid adding contaminants to the environment. In figure 14 the students are painting, and figure 15, shows the drawings after finished.

Figure 14. Students painting the road gutters in 2021

Figure 15. Final results of the paintings

4. Evaluation of the project

The student's evaluation of the project is positive (Fig. 16).

Figure 16. Evaluation of projects "The Sea Starts Here" by the participant students

In the survey, the following question was made: "Is there anything you would like to tell us?". There were some very nice answers, such as: "I think it's really cool because it's good for students to evolve" ("Eu acho muito fixe porque é bom para os alunos evoluirem"), and others to congratulate the staff.

The survey didn´t have names, it was anonymous. Yet, some of the students wrote their names.

5. Conclusions

The students reacted very well, since this project included diferent actions and subjects (nature sciences, maths and arts). They seem to have understood the problem and be willing to change their behaviours.

Beyond the students and the school community, this project is relevant to raise awareness on the theme of marine litter, since any citizen that passes nearby the drawings in the road gutters, will see them. Also, the municipaly received many questions and feedback about it, namely in the social media posts regarding the project, like in facebook.

Undoubtedly, this project constituted and will continue being an opportunity to address the problem, raise awareness on marine litter and increase marine literacy.

6. Acknowledgements

To the EBAE and "Eco-Escolas" for having an interesting programme an to invite the Sines Municipally. To the Secondary School Poet Al Berto of Sines for accepting to participate in the PEA development by the Sines municipally. To Sotinco for offering 5 L of nontoxic inks. To the Sines municipally for its strong commitment to Environmental Education and for making this project possible. To the team that coordinated the road gutters cleaning. To Doctor Mónica Martins for English corrections and suggestion done to this document.

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Environmental Friendly Homes Acoustic Isolation with Domestic Wastes

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Abstract. In today's world, where environmental problems are so present and waste is increasing, the concern with consumption Reduction, Reuse and Recycling are top priorities. These pillars of sustainability are part of our day-to-day and extend to the construction of buildings. The search for alternatives to traditional construction based on sustainability becomes increasingly important. In this project, we start from waste in order to understand how it can be inserted into the construction world efficiently. The use of recycled materials was applied in the construction of walls in order to improve the acoustic performance of these building elements. It was possible to prove with these Projects some of the principles of acoustics in buildings, namely the isolation of noise transmitted byair vibration.

Keywords. Civil Construction, Eco-friendly, Health, Noise.

1. Introduction

Civil engineering is at the base of our cities, therefore it has a direct influence in our lives, including our own health and safety [1].

There are several strands in this engineering, however, we will only focus on the acoustics of buildings [2]. Acoustics' fundamental in building construction, as it interferes not only with our daily comfort, but also with our health, being that noise can have implications for the sleep cycle [2]. Noise pollution is harmful, therefore, the development of these areas in big cities is imperative [2].

In today's world, where environmental problems are so “here” and waste is increasing, sustainability is the future. As such, sustainable construction is no exception. The search for alternatives to traditional construction based on sustainability becomes increasingly important. [2]

That's why, in this project, we start from waste in order to understand how it can be inserted into the construction world efficiently. It is also intended, through the tests carried out, to prove the essential principles of acoustics that were previously studied. Allied to the scientific part, this project will be a way to bring high school students closer to future life in a college, making known the work developed within the institution up close.

2. Methodology

To fulfill the outlined objectives, we divided the work into three parts: an initial phase of information gathering and study of the theoretical part associated with the theme along with the collection of recycled materials at home, followed by a trip to the Acoustics Laboratory [of the Section of Civil Constructions] from FEUP for the construction of wall models with the materials previously collected and their testing, finally the interpretation of the data obtained in the experiment and reflection on the results obtained.

Figure 1. Model 1: styrofoam, rocks, egg boxes, plasterboard

In the initial phase of the work, we collected as much information as possible on the subject in order to understand how, in theory, an interesting acoustic behavior using waste would be possible. We also started to collect materials at home such as: egg boxes, yoghurt packages, tuna cans, plastic lids, toilet paper rolls, plastic (air bubbles).

In the next phase, on Friday the 30th of April, we were accompanied by the materials we had collected to FEUP's facilities with the objective of building and testing the wall models with

different compositions, starting, logically, from these materials. We created four models together, all of them with different compositions and layouts, based on a 70 cm square (Fig. 1,2,3,4 and 5) [3].

Figure 2. Model 2: styrofoam, wood, egg boxes, air bubbles plastic, plasterboard

Figure 3. Model 3: styrofoam, air bubbles plastic, yogurt containers, paper rolls

Figure 4. Model 4: styrofoam, air bubbles plastic, yogurt containers, paper rolls, coffee capsules

Figure 5. Sound isolation chamber (FEUP)

3. Results

After measuring the sound intensity outside and inside the box coated with each solution, we enter the data in the table 1.

Models	Sound level in octave frequency bands dB						Global value (dB)	Approximate mass (Kg)
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Model 1	67,4,	72,1	66,7	63,1	59,7	51,9	69,0	15
Model 2	71,4	75,8	69,9	62,4	57,0	51,1	71,1	7/8
Model 3	70,8	76,5	69,9	63,3	58,1	52,4	71,5	7/8
Model 4	68,7	73,6	67,8	61,4	60,7	53,2	69,7	10
Exterior	81,7	80.8	80,8	79,4	80,4	73,2	85,0	---

Table 1. Sound level in octave frequency bands for the different models

4. Conclusion

Through the methodology used, we were able to achieve the goals initially proposed. It was also possible to prove some of the principles of acoustics in buildings, namely the isolation of noise transmitted by air vibration.

We can state that:

- The solution that presented the best acoustic behavior was Model 1.
- Next, in descending order of this behavior, are Model 4, Model 2 and finally Model 3.
- Comparing the sound insulation of each board with its mass, we realized that the main factor that influenced the acoustic behavior was its mass: Models 1 and 3 are the heaviest, verifying a better sound insulation with these solutions; the lighter ones, Models 2 and 4, presented a worse insulating behavior.

We managed to prove that it is possible to create effective solutions using recyclable materials, not only give them a second life, but also promote sustainable construction with an eye on the future, in which this seems to be the way forward.

5. Acknowledgements

This project was possible thanks to the collaboration between EB/S Clara de Resende and FEUP (University of Porto's Engineering Faculty).

We would like to specially thank to Engineers Ana Vaz Sá and Eduardo Costa from FEUP due to their orientational task in this project and also Maria Isabel Pinto, our chemistry teacher that guided us through all the process.

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[3] https://paginas.fe.up.pt/~earpe/conteudos/ARE/Apontamentosdadisciplina.pdf

Physics from Teaching to Coaching! Tesla Hands - On Science Academy

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Abstract. The aim of this contribution is to scope briefly, why and how I have just established - with the aid of a smart teamwork - Tesla Hands-On Science Academy. As a start up project, I had to set up the scientific framework of it including vision, mission, objectives, strategies, curricula and other basic standards. The kids have been classified into two levels: level-1, 5-8 years, called (junior Explorer), and level -2, 9-15 years, called (Junior Scientist)! The kid should have tasks via hands-on science activities in 5 categories /strands according to scope and sequence topics.

Keywords. Tesla, Hands-On Science, Inquiry, Guided, Directed and Full Inquiry, Project-Based Learning (PBL).

1. Introduction

From switching schools since the pandemic started to pursuing new opportunities, I started – as a Senior Physics Teacher – to think of change and making shift to my career. It's been a rough year for all of us - no one has a corner on the stress caused by the pandemic.

I've been teaching Science and Physics for about 25 years from elementary schools to high schools, for National and International curricula (IGCSE - AS, A levels, SAT, IB - PYP & DP) in Egypt, Jeddah/ Saudi Arabia and Tokyo /Japan. I enjoyed teaching so much and explored some talented students who are now highly educated, and have participated in science contests as ISEF Egypt, National Physics Olympiad, the junior Innovator, and 6th Cairo International Exhibition of Innovation.

Now, It's Time for a Change! I intended to establish an academy for Hands-On Science activities. I have a good experience in teaching kids and coaching Sc. teachers via inquiry and project-based learning. Children are considered to be natural scientists, drawn to wonder, exploration, discovery, and analysis.

In her book "Science - Not Just for Scientists!" Leonisa Ardizzone gives us simple ideas to open up the world of discovery to young children. Through open-ended explorations, you will discover how to cultivate children's natural curiosity by asking simple questions: How? When? Where? And the most famous of all children's questions: Why?

The hands-on science activities will empower children to question, experiment, and develop abstract reasoning skills [1].

From her point of view, as I used to deal with kids, I started Tesla Hands - on Science Academy.

Children in Tesla academy will explore patterns, cause and effect, size and scale, change and growth, energy, and how things work. Step-by-step activities lead children and their caregivers through a new world of discovery. It's simple and fun to investigate.

2. Why Tesla?

Figure 1. The writer with Dr. Drago Stambuk in Shiboya bookstore, Tokyo

During celebration of Egypt's national day in the embassy in Tokyo, I have met Dr. Drago

Stambuk who told me that he is a physician and poet, and he is the Croatian ambassador in Tokyo. When I told him that I am an Egyptian physicist and writer too, he asked me if I know Nicola Tesla. I said: Sure! Thereupon, he added with prideful: he was a Croatian physicist and Inventor. Hereupon, I started to read more about NicolaTesla. Once I have just discovered that Tesla was an amazing scientist - not just a physical quantity unit! - I intended to write his biography and dedicate the book to Dr. Stambuk, who let me identify Tesla world of theories, applications and innovations.

So, Tesla is considered to be one of the greatest physicists, engineers and inventors in history. The unit of magnetic flux density was named in his honor in 1960. In 1916, he invented the first alternating current (AC) motor and developed AC generation and transmission technology. Though he was famous and respected, he was never able to translate his copious inventions into long-term financial success - unlike his early employer and chief rival, Thomas Edison! [2]

2.1. Why Hands-On Science Academy?

In a bore and so passive educational environment, it is a fantastic opportunity for learners – boys and girls - to explore aspects of science that are always possible within the constraints of a normal school timetable. The academy can stretch and challenge gifted and talented learners motivate and appeal to the interests of struggling learners.

In general, Tesla Hands-On Science Academy motivates and encourages learners of different ages and abilities.

The academy can enhance the positive experiences that boys and girls have with science by allowing them to explore their own ideas and interests as well as by exposing them to role models (Scientists and Engineers) who may encourage them to think of becoming scientists themselves.

It can also help to build confidence of the learners as well as change their attitudes towards science, technology and engineering. It can also help learners develop problem-solving skills. Further, learners can also develop social skills such as cooperative learning, communication and leadership [3].

Members of the academy always have readily available projects and studies for their formative assessment. It can serve also as support base for learners participating in science expo, science Olympiads (as National/ International Physics Olympiad) as well as science fairs in their schools

Tesla Hands-On Science Academy encourages links between, schools and science centers / museums as well as schools and science research institutes. It can also serve as links to other local/ international communities and schools.

2.2. Vision

Through the Hands-On Science Academy:

1. Pupils / Students will develop scientific attitude and use it in day to day life.
2. Pupils / Students enjoy science subject and related activities.

2.3. Mission

To establish a Hands-On Science academy, which not only help students in co-curricular and extra-curricular activities, but also provide highly support in routine teaching / learning process of science subjects through its activities and inquiry and project-based learning (PBL).

2.4. Strategies

1. Establishing shared vision and mission for Hands-On Science Academy with all colleagues – my team work - and the stake holders.
2. Making stake holders and community aware about the importance of the hands-on science activities for learners, especially for talented boys and girls by using Science Kits.
3. Developing projects in science using inter-disciplinary approach, participating in science contests (National / International).

2.5. Objectives

To encourage curiosity and to create a thematic Hands-on learning experience.

2.6. Further Objectives

1. Publishing and distributing Popular Hands-on Science Books, and related literature.
2. Organizing field trips and story telling sessions about great scientists and their discoveries.
3. Organizing community services, as Mobile Science lab with no fees for kids in distant regions.

Figure 2. The writer with science staff in a weekly meeting discussing Hands - on Science topics

3. Activities Alignment

Tesla Hands-On Science activities align with the outcomes of National Science Curriculum in Egypt, and blend with both IGCSE and IB Primary Years Program – PYP.

3.1. Lessons from the past

Figure 3. Doing some Hands-on science activities with my kids in a school science club

In fact, I used to teach science and physics lessons using inquiry teaching strategy ; guided inquiry(80% teacher and 20% student), then directed inquiry (20% teacher and 80% student), eventually full inquiry (100% student's attempt) as a Hands-on science project or a scientific model by the end of each chapter or unit.

Kids were enjoying science topics and were curiously looking for science periods. It was so funny periods as I was exploring natural phenomena and science concepts with kids.

Figure 4. Using Physics Kit in Hands- On Science activities

3.2. The Selected Activities

Figure 5. Samples of the Hands- On Science kits (Biology and Physics) and some kids with hands-on science explorations

We selected the hands-on science activities from science books, edited in bilingual activity books / booklets (English- Arabic) to suit both national and international curricula as well.

Children are classified to two levels; level-1 for 5-8 years kids (Junior Explorer), and Level-2 for 9-15 years pupils (Junior Scientist).

The main course duration is three months, 3 sessions weekly, 120 min /session, includes 30 min for a lecture + 90 min for Hands-On Science activities / projects. The kids will be given related assignments to complete further tasks (at home activity).

After the child pass level-1 or level -2 and has got skills and has the ability to complete studying at lab zone, he/she will be asked to start an advanced course.

3.3. Strands of Science

Topics:

- Life Science
- Physical Science
- Earth and Environmental Sciences
- Energy and Mechanics
- Space and Technology

Here are some instructions /inquiries regarding to physical science:

- The kids will investigate energy transformation and transference using electrical circuits.
- Understand how electricity is generated and which methods are most sustainable.
- Discuss prior knowledge of energy/electricity.
- Predict and test materials as conductors or insulators of electricity.
- Using electromagnets in toys.
- Examine broken and working motors and follow the energy transformations taking place.
- Observing a solar panel working [4].

3.4. Science Project Topics

Here are suggested Science project / activity topics for kids to approach inquiry; guided, directed and full inquiry.

3.4.1. Life Science

- Bacteria: Does reusing water bottles increase their bacterial content?
- Bacteria: How clean are the tops of soda cans, and what is the most effective way to clean them?
- Ionizing Radiation: How does ionizing radiation affect the germination and growth of plants?
- Yeast: How does the amount of carbon dioxide generated by yeast depend on temperature?

3.4.2. Physical Science

- Chemistry: Which plants and vegetables make the best dye?
- Electrochemistry: How do the levels of salt and vinegar affect the amount of gas produced by electrolysis of water?
- Magnetism: How does temperature affect a magnet?
- Solar Cells: How does temperature affects solar cell energy production and storage?

3.4.3. Environmental Sciences

- Acid Rain: How does acid rain affect algae and bacteria?
- Air Pollution: What effect does sulfur dioxide have on lichens?
- Lead: What is the lead content of drinking water at home and at school?
- Water Pollution: Does pollution affect oxygen production in aquatic plants?

3.4.4. Earth and Space Science

- Greenhouse Gases: How does the concentration of carbon dioxide affect plant growth?
- Rocks: Does age affect the hardness of sedimentary rock?
- Weather: Is there a relationship between the phases of the moon and the weather?

3.4.5. Mechanics and Energy

- Solar Cells: How does temperature affect the efficiency of a solar cell?
- Wind Energy: Can wind power be stored compressed air?
- Wind Energy: What factors affect the generation of electricity by wind turbines? [5]

Figure 6. Some of my talented Students who participated in National Physics Olympiad, and 6th Cairo International Exhibition of Innovation

4. Conclusions

We started Tesla Hands - On Science Academy as an intensive summer course (3 months, 12 sessions monthly, with 4 strands: physical science, life science, Earth science then simple knowledge of space and technology.

Actually, we are still in the beginning and surely we will update the academy by fruitful discussions, and exchanging experiences with successful academies and professionals. I admit that I have got benefits from the past papers of HSCI conferences" Handbooks" [6].

Eventually, I hope to see teaching / learning science in all schools to be based on STEM (Science, Technology, Engineering and Mathematics). And to see children use not only "Science text book" but also "Science Kit" as well.

Surely, every student can acquire and effectively apply the knowledge, attitudes, and skills necessary to thrive in his/her studies, career, and will enjoy adult life.

5. Acknowledgements

I deeply appreciate my smart team work in Tesla Academy, who works in a bee- hive: Jasmine (Microbiologist), Rawdah (Physicist), Ahmed AlJazzar (Mechatronics Engineer), Enas (Chemist), Mahmoud Tarik (Electronics Engineer) and Aya Hamada (Business Information System Engineer).

And to Dr. Manuel Filipe, HSCI Network President, who managed – for the successive 2nd year to access the HSCI2021 On-line conference; in spite of the pandemic situation of COVID19.

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The Bacteria Geobacter as a Perspective Source of Green Electricity

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Abstract. The research provides information on the structure and operation of bacterial fuel cell, which uses the electrical properties of the anaerobic bacteria geobacter. The result of the authors' research is creation of a highly efficient bacterial element, which can generate constant current and voltage for a long time, thanks to construction elements developed by the authors. Industrial use of this cell, for example, in sewage treatment plants, will not only help to dispose human and animal wastes effectively, but also to obtain electrical energy at the same time.

Keywords. Bacterial Fuel Cell, Electricity, Geobacter Bacteria, Ni Foam, Sewage Treatment Plant.

1. Introduction

Due to the fact that the amount of non-renewable energy resources on Earth is decreasing sharply, humanity is more and more trying to replace them with renewable energy sources (wind, sun, water, biogas, etc.) Not so long ago anaerobic bacteria-geobacter were discovered, which in the process of their life activity separate electric charges into + (proton) and - (electron) and throw them out into the environment. In the environment these charges oxidize or restore various chemical compounds. In some European countries, bacteria geobacter are already being used to turn dangerous chemical compounds into non-dangerous ones. There have been a lot of research on the possibility of using these bacteria to produce "green" electricity lately. Obviously, the generated electricity will be the result of disposal of various organic wastes. Therefore, the authors set a goal to create an energy source in which organic waste with the help of microorganisms-geobacter will be effectively used to generate electricity.

Objective: To develop an efficient source of renewable electricity using the electrical properties of the bacteria geobacter.

Hypothesis: The life activity characteristics of geobacter bacteria can be used effectively to generate electrical energy.

Tasks: 1. To research various literature sources on the topic; 2. To find bacteria suitable to electrical power generation (presumably, geobacter) in silt deposits or near sewage treatment plants; 3. To develop a bacterial cell that can be used as electrical power source; 4. To find out under which parameters the developed power source will operate with the most efficiency; 5. To try to use the obtained elements in electricity production.

2. Literature review

Oxford University Press published an article [1] in which scientists César I. Torres, Andrew Kato Marcus, Hyung-Sool Lee, Prathap Parameswaran, Rosa Krajmalnik-Brown, Bruce E. Rittmann conducted a detailed analysis of the possibilities of obtaining electricity in the process of bacterial activity. The work shows that there are three ways of transferring electrons from bacteria to the anode (Fig.1).

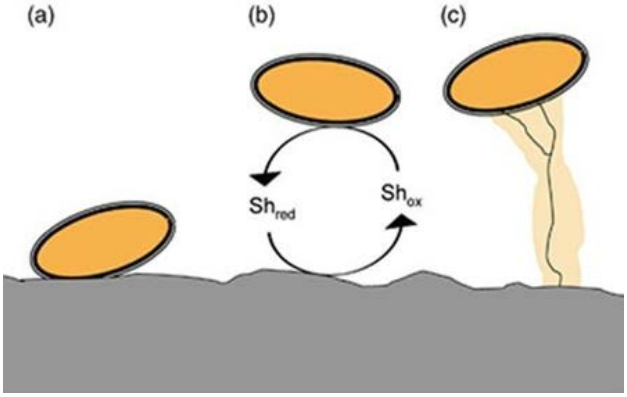

Figure 1. Image source: [1]

Method A – a direct contact of bacteria with the anode. Method B - charge transfer by means of a shuttle. Method C - through a solid conductive matrix. In case of the method A, a small amount of bacteria can be placed on the surface of the electrode, which will limit the current density. In case of the method B the current density is also limited due to the slow diffusion flow of the electron shuttles. And in case of the method C the highest possible current densities can occur. The way the

electrons are transferred will determine the current density and efficiency, and as a consequence the efficiency of the fuel cell. Different bacteria species can use different methods for electron transfer.

Also, in this article there is a schematic diagram of the fuel cell (Fig. 2).

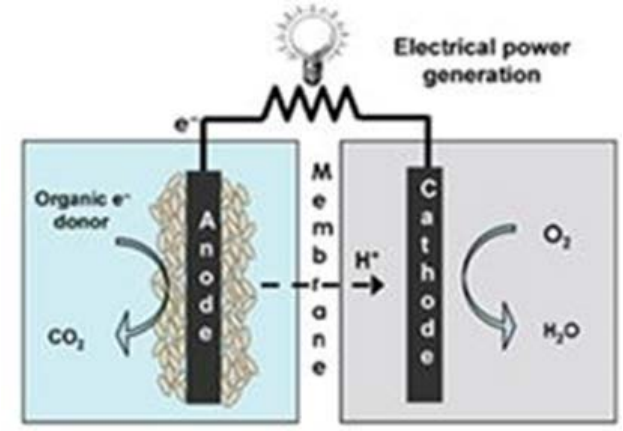

Figure 2. Image source: [1]

American scientists Derek Lovley and David J. F. Walker [2] studied the electrical conductivity of bacterial species of the genus geobacter. The scientists concluded that the presence of conducting protein nanowires explains extracellular transport of electrons over long distances. This is explained by the different genetic composition of bacteria, especially the presence of several genes. The scientists obtained the evidence that it is the bacteria geobacter sulfurreducens that has the greatest amount of the e-pili gene, which contributes to transport of electrons over long distances. The data from the electronic microscope show the presence of a large number of nanofibers around the bacterium (Fig.3A), Figure 3B shows Fe (III) 3 oxide attached to the nanofibers. In this case, the geobacter sulfurreducens throws its electrons on the Fe (III) oxide, converting it into Fe (II) oxide.

The work of American scientists deserves great attention, as they have conducted in-depth and effective research on the electrical properties of different types of bacteria geobacter.

A Japanese researcher Souichiro Kato [3] in his work conducted a study on how anodic potential affects the current production by 6 kinds of geobacter bacteria. One of the interesting results is that the bacterium geobacter sulfurreducens is capable of generating high current density in a wide range of anodic potentials (Fig. 4).

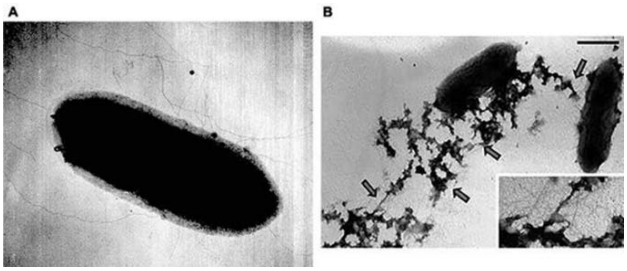

Figure 3. Image source: [2]

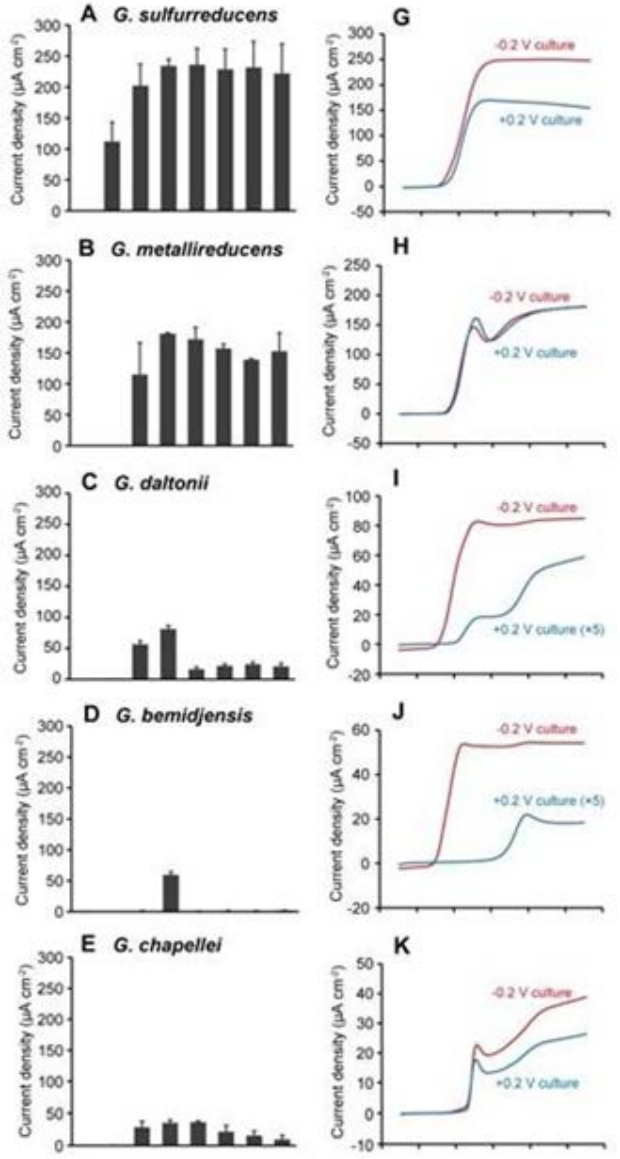

Figure 4. Image source: [3]

Voltammetric studies were also conducted. The scientist had a conclusion that the bacterium geobacter metallireducens uses only

one mechanism to transfer electrons to the anode, while other bacteria use several mechanisms to transfer electrons to the anode and can change them depending on the anode potential.

A group of New Zealand scientists, Audrey S. Commault, Gavin Lear, Richard J. Weld [4] explored the possibility of using geobacter for wastewater treatment. First the scientists grew large colonies of geobacter in a special nutrient medium at certain potentials on the electrodes. The scientists explored the electrical parameters of the fuel cells they created, including the power output. After that, the fuel cell with bacteria in it was used to study the possibility of wastewater treatment under natural conditions. After the fuel cell was placed for 6 weeks in wastewater its electric characteristics did not become worse, which proves the possibility of geobacter existence in more aggressive conditions than its natural environment. The results of the experiment also indicate that the presence of other bacteria did not prevent geobacter from producing electricity equally efficiently.

Hanno Richter and a group of scientists [5] explored the possibility of transporting electrons by geobacter bacteria onto gold electrodes. Some researchers have so far used carbon electrodes more often since some species of bacteria do not transfer electrons to gold. But the study showed that it is the bacteria geobacter sulfurreducens that can effectively transfer electrons to the gold anode. The authors of the work provide pictures from SEM (Fig. 5) where biofilm covering the surface of the gold electrode is clearly seen, also nanowires binding bacteria to each other are clearly distinguishable in the picture. In the pictures 5a, 5b and 5c bacteria covering the electrode can be seen. In the picture 5D the nano wires linking the bacteria to each other can be seen. Scientists suggest coating the electrodes with a thin layer of gold, by sputtering (as a saving measure) and using it, for example, in fuel cells.

The scientists' research is very promising, but the purpose of using gold electrodes due to their high cost is not quite clear.

The review of the literature allows the authors to conclude that the bacteria geobacter sulfurreducens has a unique ability to utilize organic waste products of humanity with the subsequent production of electrical energy.

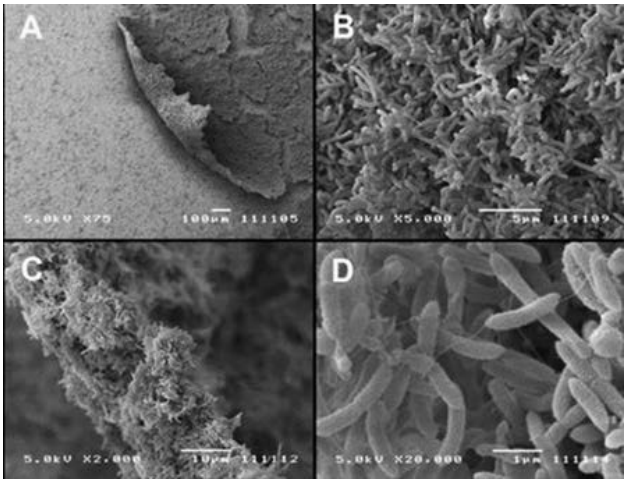

Figure 5. Image source: [5]

3. Materials list and experiment procedure

3.1. Materials list

Table 1. Materials

Title	Manufacturer
Sludge	-
2 Carbon electrodes 12cm^2	-
2 Ni electrodes 12cm^2	Germany
2 Nickel-foam electrodes 500cm^2	China
Ion-permeable membrane	USA
Red diode	China
8 Plastic containers	-
Cathode cylinder	*
Synthetic thread from a water filter	China
Wires	-
3D printer	-
Microscope	Motic Eirope
Multimeter	PeakTech
4 Membranes from a Ni ion battery	China

* Daugavpils Secondary School 13

3.2. Experiment procedure

3.2.1. Elaboration of power source Nr.1

The authors of the work have designed a scheme of a microbial fuel cell (Fig.6).

Carbon electrodes, nickel plates, and nickel foam plates were chosen as electrodes. The area of the plates is the same (12 cm^2). Several microbial fuel cells were made according to the scheme (Fig.7).

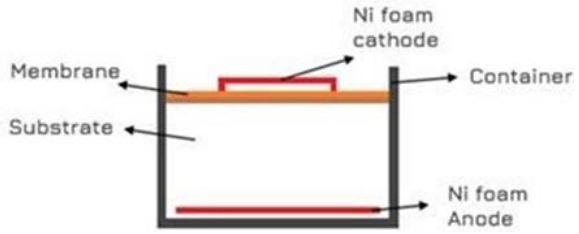

Figure 6. Diagram of power source No.1

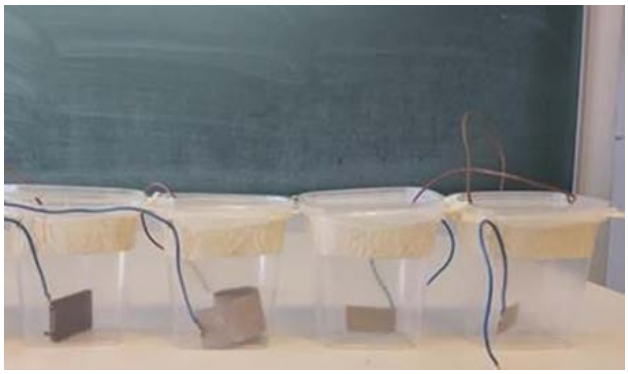

Figure 7. Cells

3.2.2. Substrate for the fuel cell

In one of the ponds of the swampy area of Daugavpils district sludge was taken for the fuel bacterial cell. In the video [6] you can see that the process of sludge selection is accompanied by the release of gases (that smells like methane and hydrogen sulfide), the process of active gas release also indicates the saturation of sludge with bacteria geobacter. The anode chamber of the cell was filled with sludge (Fig.8).

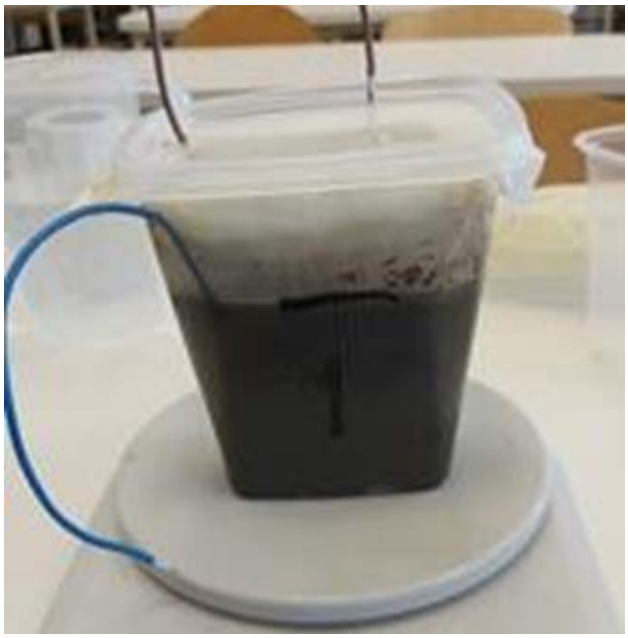

Figure 8. Cell with substrate

3.2.3. Elecrical indicators of fuel cell No.1

In all three cells with three different electrodes, the EMF (Electromotive force) increase was approximately the same, and the maximum EMF value was reached on day 3.

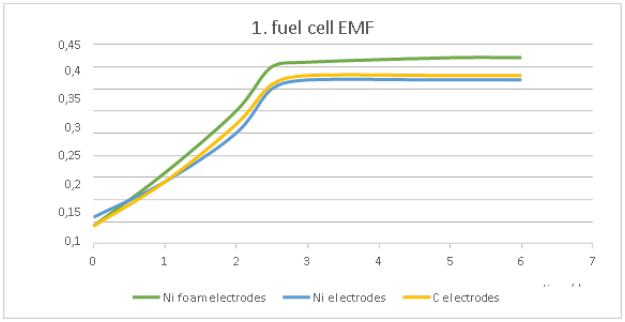

Figure 9. EMF of element 1 versus time

This can be explained by the fact that the bacteria need time to attach to the electrode and the bacteria that did not have enough space on the electrode must line up in conductive chains to transfer the charge to the anode.

The operation of the current source in the short-circuit mode was studied. The results can be seen in the graph (Fig.10).

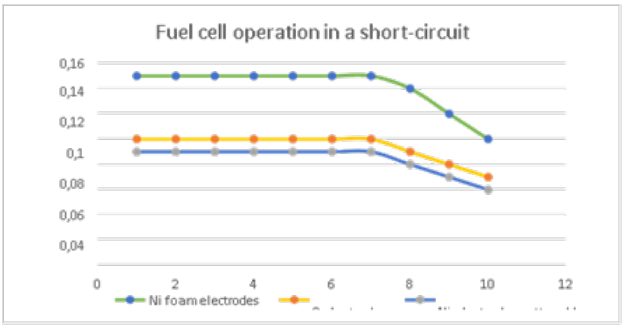

Figure 10. Element 1 in short-circuit mode

From the graph it follows that the current in the source, the electrode of which is made of nickel foam is 1.45 times higher than in the sources with smooth carbon and nickel. Probably it is because the surface of the electrodes made of nickel foam is very porous (Fig.11) and the surface area is much larger, the bacteria have more place for attachment to the anode.

On day 8, a gradual decrease in current strength is observed when the source is operated in short-circuit mode. When examining the source, it was found that gas

bubbles are formed under the membrane, which interfere with the flow of current. Based on the conducted pilot studies, it was decided to improve the construction of the current source.

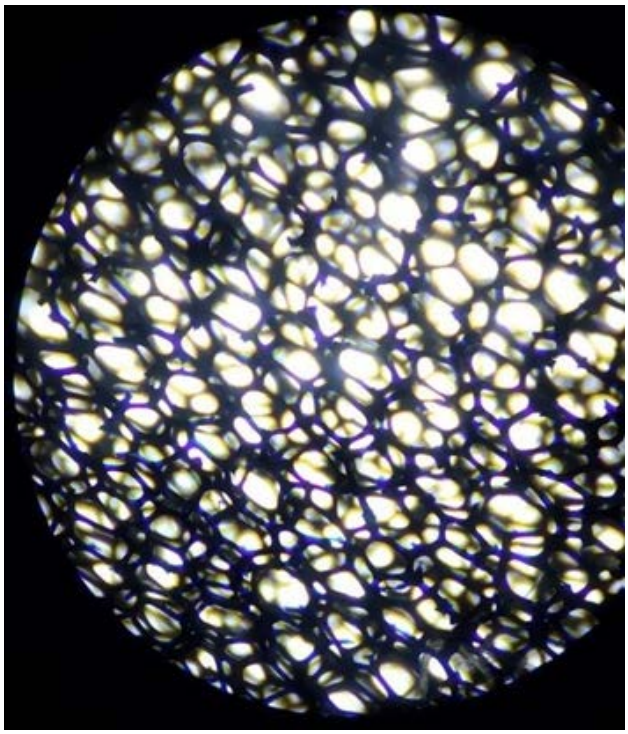

Figure 11. Structure of the Ni foam surface

3.2.4. Development of electric source No.2

Based on the results of previous studies, the authors decided to make the electrodes from nickel foam. To ensure free gas escape the membrane was placed vertically and the distance between the cathode and the anode was made smaller to reduce the internal resistance. The area of the anode was made as large as possible. Now the scheme of the cell resembles the shape of a battery. (Fig.12)

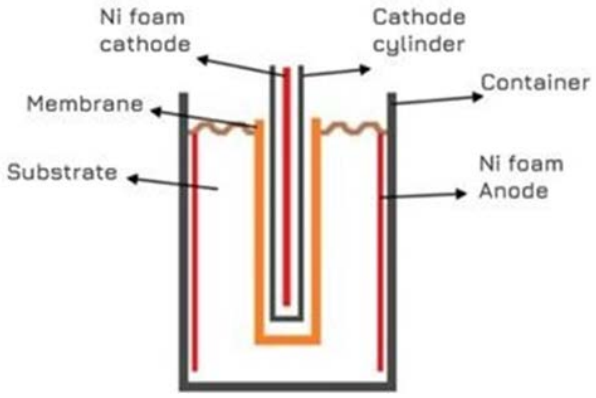

Figure 12. Diagram of power source No.2

The sequence of cell creation can be seen in the Figure 13.

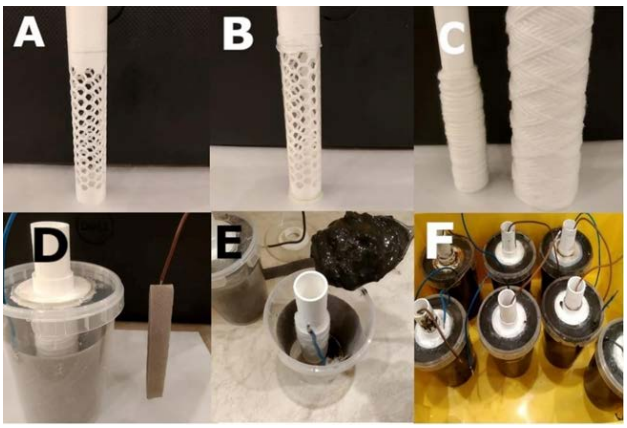

Figure 13. Sequence of cell formation

A. The cathode cylinder was made using a 3D printer.
B. The cathode cylinder was covered with a membrane which is able to pass ions but not bacteria.
C. The membrane was isolated from large sludge particles using synthetic thread from a water filter.
D. Inside the container near the wall there is a cylindrical anode made of nickel foam with a blue wire and a cathode made of nickel foam with a brown wire.
E. and F. 8 current sources were made to be able to connect them consistently and study their operation when powering the LED.

4. Data analysis

After the research conducted by the authors, the following results were obtained.

Electrodes with a large surface area, such as nickel foam electrodes, should preferably be used as electrodes for a bacterial fuel cell. This is because a large number of bacteria will be able to attach simultaneously to such an electrode.

The maximum EMF and current delivered by the source will be observed starting from day 3, due to the fact that time is needed for the creation of bacterial colonies on the anode.

Experimental results showed that the ion-permeable membrane between the cathode

and anode chambers must be placed vertically for free exit of gas bubbles, which are also formed during the vital activity of bacteria.

Also, the anode and cathode should be as close together as possible to reduce the source resistance.

The authors of the work applied these sources for useful purposes. Eight microbial cells connected consistently gave an EMF of 2.2V and when the payload in the form of a red LED was turned on, the diode voltage was 1.75 V, and the current was 0.12 mA.

You can see how the device works in the video at the link. [7]

The developed source has a cathode current density of 17.14 μA/cm^2.

The total mass of the sludge in 8 fuel cells is 1.7 kg, and this microbial battery worked without significant changes for 1.5 months.

The prospect of improving the source is the possibility of methane collection. As a result of studies on the creation of a microbial fuel cell, as well as studies [5], the authors can offer a scheme and a prototype of an industrial plant for the production of electrical energy at sewage treatment plant.(Fig.14 un Fig.15). In order to make such plant cheaper, a possibility to replace nickel foat with stainless steel must be researched.

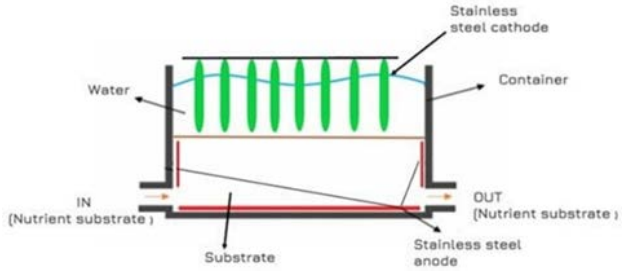

Figure 14. Diagram of industrial equipment

Figure 15. Prototype of the industrial equipment

Since the production of renewable energy in recent years is an increasingly important issue, the research conducted by the authors of the work deserves attention and is promising, as research in this direction in the world is just getting started.

5. Conclusions

The analysis of the literature showed that the use of bacteria geobacter to produce electrical energy is highly topical. And the development of microbial fuel cells is a promising direction.

Sludge samples were collected with large amounts of anaerobic bacteria presumably geobacter.

As a result of the authors' work, a fuel microbial cell was created. To increase the efficiency, highly porous nickel foam was used as a cathode and anode. The area of the anode was made as large as possible. For effective removal of accompanying gases (the presence of gases in the source increases its internal resistance) the ion-permeable membrane was placed vertically. To reduce the internal resistance of the source the cathode and the anode were placed as close to each other as possible.

A red LED was connected to 8 consistently connected fuel cells. During 1.5 months of the power source operation the LED voltage was 1.75 V and the current flowing through the diode was 0.12 mA. Considering, that the total mass of the sludge was 1.7 kg and the fuel (sludge) is completely free, the work of the source can be called effective. Also, the authors of the work offer a model of a fuel cell, which could be used at sewage treatment plants, where the disposal of waste products would produce electrical energy.

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[6] https://youtu.be/9LKJG-eFK6Qv

[7] https://youtu.be/_bVGOtDCE98

Science Tech Weekend School "Welcome To Photovoltaic Universe!"

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Abstract. 5 young scientists of NTU "KhPI" created Science Tech Weekend School "Welcome to Photovoltaic Universe!" and in the spring of 2021 every Saturday with Kharkiv High School/Pre-University/Secondary School (ages 14-18) to take part in the working model creation of a photovoltaic installation equipped with a tracking system for the "sun". The Science Tech Weekend School project is a one-day weekend event lasting 7 hours, in the schedule of which there are several training master classes for school students from NTU "KhPI" young scientists to solve a specific technical problem. The work on creating a real solar battery with a rotary control module from scratch allowed the project participants to be acquainted with the principle of operation of solar cells and gain practical skills in assembling a battery from individual cells by soldering and then placing them on a surface to create a solar battery. At the stage of solar cells preliminary testing and during the final testing of the battery, the participants gained skills in working with measuring equipment and learned how to make calculations to determine the efficiency of both an individual solar cell and the entire battery. Engineering calculations were carried out to determine the most efficient location of the tracking sensors and the required generated power that would allow charging wearable devices.

Keywords. Photovoltaic, Tracking System, Solar Cells, Engineering Problem, Measuring Equipment.

1. Introduction

In planned activities wiil be used the concepts of photonics from two active research areas at NTU "KhPI": solar energy (the creation of solar cells) and the production of electricity by photovoltaic power plants. These areas of research are consistent, that is, to study the production of electric energy, it is necessary, accordingly, to first create solar photovoltaic panels. Young scientists have previous experience in hands-on science [1-4], specialists in the field of photonics and optics, the conversion and transmission of electrical energy, will provide a series of workshops during 10 weeks. This will allow children to get acquainted with important practices in scientific research, such as: using other people's experiments in their interests, putting forward valid hypotheses and testing them, perseverance in understanding and solving the problem, and, finally, the desire to improve the work of the solution. The desire to develop energy storage systems for the operation of photovoltaic power plants, as well as discussing the results obtained, experiments. High School/Pre-University students will be involved in absolutely all stages of creating these structures.

The aim of the events is to raise awareness of the processes associated with the generation of electricity by photovoltaic power plants. The work of the photovoltaic power plant directly with the grid will be reviewed. The application of energy storage systems for the operation of photovoltaic power plants will also be considered. The main part of the activity will focus on how to determine the altitude of the sun above the horizon and how to establish tracking systems. It is planned to present the work of solar PV panels in stationary mode, seasonal change of tilt angle, horizontal and horizontal-vertical tracking. The participants of the event will program an arduino controller to create a light source tracking system. High level programming languages of XOD type will be used to solve the task.

A solar battery designed for placement on a tracking device will be made from individual elements based on crystalline silicon. Solar battery power at 8 watts will provide the ability to power the auxiliary needs of the tracking device and generating the 5V output voltage to power external devices through a standard USB port. Using of silicon as the material for solar cells will allow us to clearly demonstrate the different absorption efficiency of solar spectrum individual components during testing a manufactured battery. Mounting a solar battery on a tracking device will increase its efficiency and clearly demonstrate a change in the power generated by the battery during daylight hours.

The programmed controller will be combined with a solar panel to create a layout of a photovoltaic power plant equipped with a tracking system. Familiarization with the principles of solar power plants, how to track the sun and create a layout of the solar panel with the ability to track the light source will be the result of the event.

2. Science Tech Weekend School schedule

Classes at Science Tech Weekend School were held every second Saturday of the month according to a previously prepared schedule. The duration of the time to complete the project is 7 hours. Between Saturdays with classes, on Saturdays, we prepared materials for the class and created templates for the next classes.

2.1. Tech preparation part

- Measurement of solar cells parameters. Duration: 2 hours.
- Assessment of the state of equipment for the event. Duration: half an hour.
- Processing and reworking of lecture material. Duration: half an hour.
- Printing elements of layouts on a 3D printer. Duration: 0-2 hours.
- Assessment of the state of equipment for the event. Duration: half an hour.
- Calibration of sensors. Duration: half an hour.
- Setting up demonstration layouts. Duration: half an hour.
- Processing and reworking of lecture material. Duration: 1-3 hours.

2.2. Event Saturday

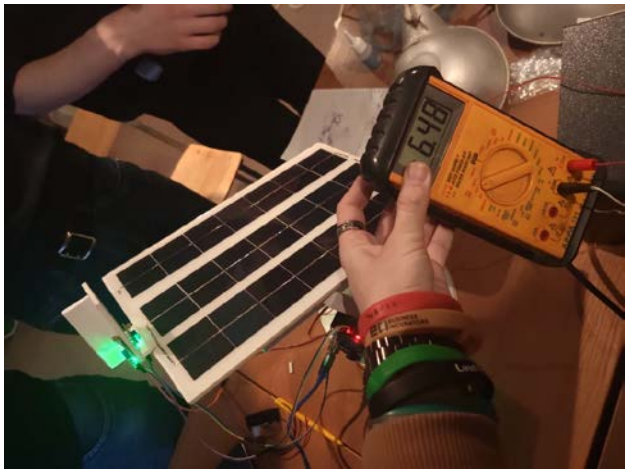
- Lecture part. Physics of solar cells. demonstration of light source with various spectrum influence on solar cells efficiency. Duration 45 minutes.
- Answers to questions. Duration:15 minutes.
- Practical part. Sorting solar cells from batch by their short circuit current. Soldering solar cells into strings. Controling the strings parameters. Duration 50 minutes.
- Coffee break. Duration 10 minutes.
- Practical part. Fixing soldered strings on the solar battery base. Filling strings on base by quick-fix epoxy. Control of solar battery parameters. Duration 50 minutes.
- Lecture part. Generation of electric energy at photovoltaic power plants. Demonstration of the main elements of the photovoltaic power plant (photovoltaic panel, converter, controller, energy storage system, load) on a model. Duration: 45 minutes.
- Answers to questions. Duration:15 minutes.
- Lecture part. Calculation of sun position. Basic ways to track the sun. Duration: 25 minutes.
- Answers to questions. Duration: 15 minutes.
- Practical part. Layout assembly of a photovoltaic panel with sun tracking system. Duration: 30 minutes.
- Practical part. Programming and adjustment of the controller for monitoring the position of the sun. Duration: 50 minutes.
- Summing up. Duration: 25 minutes.

Working during one event to create a real solar battery "from scratch" allowed the project participants to get acquainted with the principle of operation of solar cells and gain practical skills in assembling a battery from individual cells by soldering and then placing the solar battery. During the preliminary testing of solar cells, as well as during the final testing of the battery, the participants learned how to work with measuring equipment and learned how to make calculations to determine the efficiency of the solar cell and the entire battery.

The concrete result of the project was the creation of a working prototype of a solar battery installed on a tracking device, the power generated by which will allow charging wearable devices. This could raise awareness of the project participants about renewable energy sources and gave them an understanding of the specific way to introduce solar energy into everyday life.

In the following sections, we will take a step-by-step process of creating a system with students under our guidance.

a)



b)

c)

Figure 1. Final group photo and photo of the assembled installation from one of our events

3. First part – make solar panel for PVT system

The manufacture of a solar mini battery for equipping a maquette of solar tracker was carried out with the desire to repeat the process of manufacturing a real solar battery as much as possible.

At the first stage, a preliminary check of individual solar cells (SC) quality was carried out, in order to sort the best samples for equipping the mini battery. Solar cells produced in PRC on the base of polycrystalline silicon with dimensions 55*35 mm were used. After preliminary rejection of the solar cells, they were soldered in 7 pieces into strings, while the elements were connected in series. After that, the finished strings were also connected in series in three pieces for installation on the base of the mini battery. Thus, the total number of elements in one solar tracker maquette was 21 pieces.

For soldering, standard tinned copper busbars were used, intended for the manufacture of solar panels; for applying the flux, a special felt-tip pen was used to ensure the minimum consumption of reagents, as well as to minimize the negative effect of the flux on the antireflection coating of the SC photoreceiving surface. The appearance of the mini battery during the soldering process is shown in figure 2.

To give hardness to the solar mini battery and protect it from external factors, the SC connected in strings were placed on a base 300*210 mm in size, made of foamed PVC plastic with a thickness of 5 mm.

Also, on the back side of this base were constructive elements for installing the parts of the tracking system. A general view of the solar mini battery base is shown in figure 3.

The front surface of the solar cell was protected from unfavorable factors, as well as the solar mini-battery was sealed by filling a layer of transparent epoxy resin about 3 mm thick over strings which was placed on the base.

Highly transparent epoxy resin provides good mechanical strength to the entire structure and also minimizes solar radiation loss.

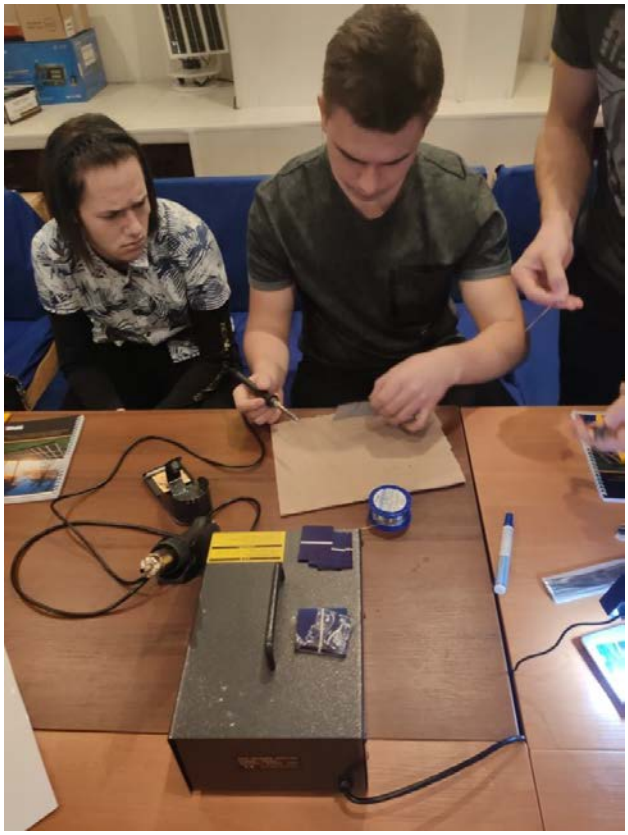


Figure 2. Soldering process

Figure 3. Solar mini battery base

The process of filling the SC strings with epoxy resin was carried out as follows. On the edges of the plastic base, with the help of self-tapping screws, formwork elements made of the same foamed PVC with a thickness of 5 mm and a height of 15 mm were attached, which, when assembled, ensured the presence of a rim sufficient to prevent overflow of epoxy resin during the actual filling and subsequent polymerization. The appearance of the base with the installed formwork is shown in figure 4.

Figure 4. SC strings

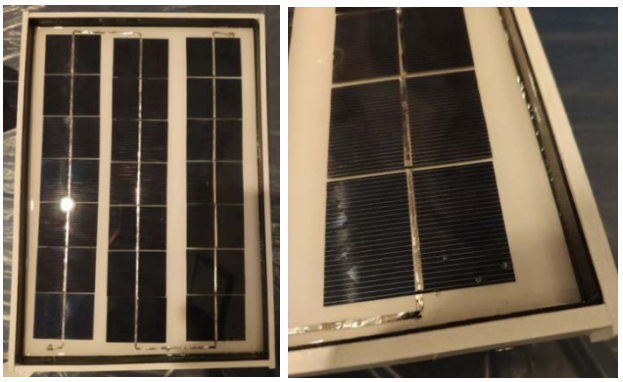


Figure 5. Mini battery, filled by epoxy resin

At the next stage, the previously soldered SC strings were neatly laid on the surface of the base and preliminarily fixed on it with drops of cyanoacrylate glue. This was necessary to prevent the SCs from floating to the surface of the resin after they were filled. The actual filling process was carried out with an epoxy resin prepared according to the instructions. The mini battery, filled by epoxy resin is shown in figure 5.

The polymerization time of the resin was approximately 6 hours, which made it possible to achieve free release of all air bubbles to the surface, and the resin was fully cured after 24 hours. After the resin polymerization, the formwork was removed on the sides of the mini battery base and the mechanical preliminary and finishing treatment of the resin monolith edges were carried out to give the mini battery an aesthetic appearance. The final view of the solar mini battery prepared for installation on the tracking device is shown in figure 6.

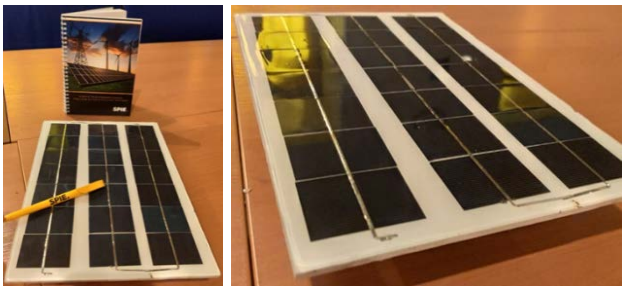


Figure 6. Solar mini battery prepared for installation on the tracking device

4. Second part – make PVT system and programming

The main objectives of our part of the event may be the following:

- increase the participants' understanding of why and how the sun is used in the energy sector.
- increase the understanding of the efficiency of energy production by solar power plants depending on various factors.
- give an insight into the methods for determining the position of the sun above the horizon.
- build and program a mock-up of a photovoltaic panel with the ability to track the position of the sun above the horizon.

A sequence of activities was used to fulfil most of the objectives: theoretical training through a presentation, practical demonstration on pre-prepared mock-ups and stands, and discussion.

4.1. Key steps in the event

Let's look at each of the stages of the event in more detail. For ease of explanation, they are broken down by task, but in reality several tasks were carried out simultaneously and some experiments were also used to solve several tasks.

4.1.1. Preparatory stage

During the preparatory stage, the structure of the event was developed, consisting of an alternation of theoretical and practical blocks, the mock-up concept presented in figure 1 was formed, and several code variants were prepared.

After that, a preliminary version of the mock-up was made and a performance test was carried out. As a result, it was decided to place three wheels in the base to increase the reliability of operation. The final version included: an Arduino uno platform, 3 analog-digital light sensors, two microservo drives, a digital voltammetre, a LED load and structural elements. Specific items were selected based on the speed of replacement in case of damage, so the most common and reliable elements were used.

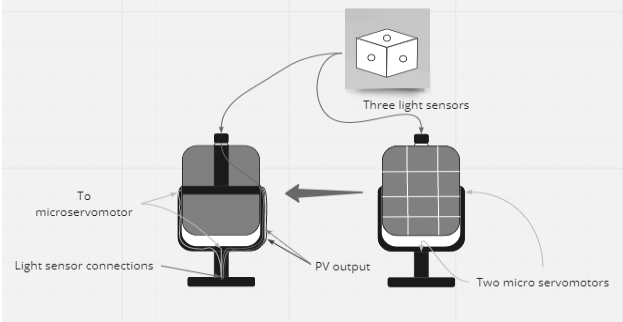


Figure 7. Mock-up concept

4.1.2. The place of solar power plants in the energy system

The participants must understand what place and why solar power plants have in the energy system, what types of plants exist, and what additional equipment they need.

For this purpose, they are shown the main types of solar power plants with the help of a presentation and explained how they are operated with the help of primitive and very common analogies. An example of such an analogy is a storage tank in a summer shower as an analogue to a solar collector.

In the practical part, the participants were given access to a stand, consisting of a 30W photovoltaic panel, a light fixture with two 60W incandescent lamps (for cloudy weather) and a case with a controller, battery and load. The stand view is shown in figure 8.

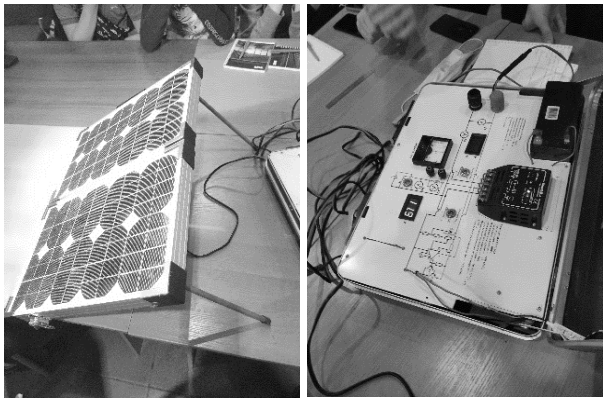


Figure 8. Laboratory stand

After explaining the purpose of all the elements, the students had the opportunity to interact with the stand to see how the position of the light source affects the efficiency of the photovoltaic panel generation.

At the end of this part there was a discussion section with clarification of unclear points and, if the participants were interested, a discussion of the particularities of the use of the The influence of the environment on the efficiency of solar power plants in Ukraine.

4.1.3. The influence of the environment on the efficiency of solar power plants

In this part of the lesson, participants use theory and practice to understand the impact of the type and location of the light source on PV panel generation.

The theoretical block includes a presentation on the history of the study of light, the change in its parameters as it passes through different layers of the atmosphere and the effect of the angle of incidence of the sun's rays on the efficiency of the PV panel's generation. In order not to lose the attention of the audience, small digressions are made with more mundane examples. For example, "Why is the sky blue? - It is the light of the blue spectrum that scatters in the upper layers of the atmosphere". An example image to explain scattering [5] is shown in figure 9.

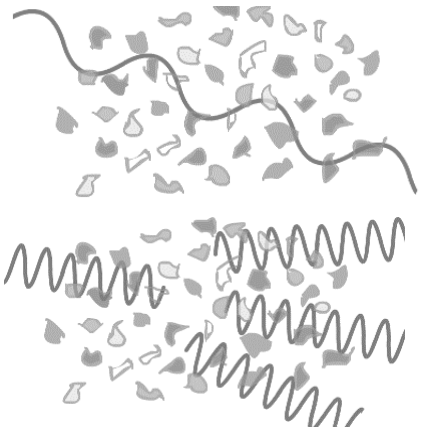


Figure 9. Red and blue light in atmosphere

In the practical block the students compare the voltage at the output of the PV panel under different light sources (sunlight, compact fluorescent lamps, incandescent light bulbs). The students also gain a preliminary understanding of the effect of the angle of incidence of the sun's rays on the efficiency of the PV panel generation by changing the position of the PV panel or the location relative to its light source.

In the discussion block, the students have the opportunity to ask clarifying questions and the lecturer makes sure they understand the main points according to the objective of the stage.

4.1.4. Determining the position of the sun

In the theory block, the presentation deals with the basic concepts and formulas for calculating the hour angle, azimuth, declination and altitude of the sun. It is important not only to give formulae but also to provide visual information. An example image to explain the basic angles is shown in figure 10.

In the practical block, if there is enough time, the sun's position can be calculated with the participants, followed by a check. If a compass is not available, the time of sunrise or sunset can be calculated for the current day and the result compared with the reference data.

In addition to answering the questions in the discussion block, it is useful to understand how meteorological data related to solar radiation is obtained, as well as to discuss alternative options for tracking the position of the sun by photovoltaic panels. The main options are:

timer-driven orientation changes based on pre-calculations, finding the optimum position based on one and three light sensors.

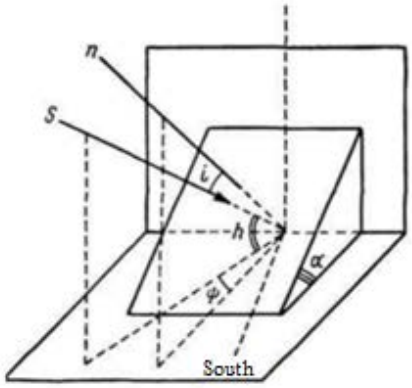


Figure 10. Basic angles which are used in calculations

4.2. Layout assembly of a photovoltaic panel with sun tracking system.

To create the installation, you will need: a solar panel covered with epoxy resin on a 20x30 cm plate with a protruding part; base plate; skeleton; 2 servos to rotate the plate and skeleton; wheels for the stability of the frame during movement; Arduino control board; connecting wires; voltammeter, photosensitive sensors. Fastening materials such as: glue, nails, screws, double-sided tape, soldering iron.

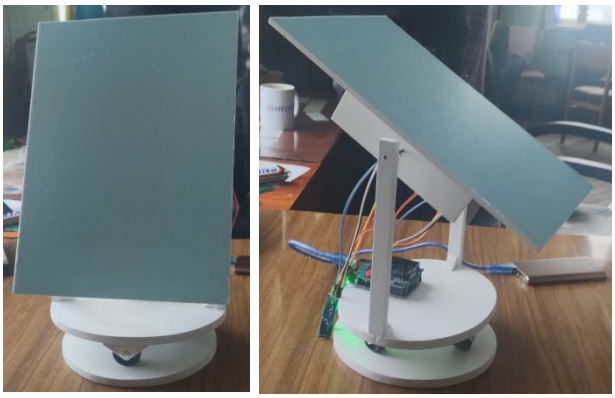


Figure 11. Skeleton base for solar panel and control system

We glue the second servo to the smaller "leg" of the frame and fix it with a nail. The counterpart is fastened with nails to the protruding part of the solar panel. A metal axis is threaded through the protruding parts. The solar panel is mounted on the frame by inserting the axis into the groove made in the larger “leg” of the frame, and on the other hand, connecting the counterpart of the servo with the servo itself.

We solder connecting wires to the terminals of the solar panel and connect them to a voltammeter.

Using the connecting wires, we connect the power supply of the servo drives to the control board and the power supply of the voltammeter, power supply and control of the light sensors.

We place the light sensors depending on the choice of the programming method.

4.3. Mock -up programming

The section is also in three parts, but the discussion takes place in two stages. This is used to compose an algorithm for the sun-tracking system during the discussion.

In the theory block, participants who are not familiar with arduino programming are explained the basic programming principles, program structure, basic syntax and the use of libraries with code examples through a presentation. Participants who know how to program arduino are actively involved in the discussion.

The theoretical block is followed by the first stage Lecturer reads algorithm variants prepared in advance: automatic turning with predefined step, horizontal and then vertical search for maxima based on one sensor, search for maxima based on three sensors. Participants are given an opportunity to use either a pre-designed algorithm or come up with a personal one. The important point at this stage is to incorporate as many views as possible to form common ownership, even with the possibility of a small loss of efficiency. Using a whiteboard to visualise the algorithm in combination with verbal labels for each step can also increase audience engagement. In addition, it is possible to divide the group into two subgroups to speed up the process. One of them should be in charge of forming the algorithm, and the second one should assemble the layout and install the sensors on it.

In the practical part, direct programming of the mock-up is carried out, followed by testing its effectiveness and possible improvement in

order to achieve the desired result. To do this, the opportunity to write a program is given to the participant or participants who understand programming best. It is also convenient to use a projector to involve the rest of the participants in the process. This block ends when the participants and the organizers can clearly confirm that the tracking system works. An example of the code developed by the participants is shown in figure 12.

```
void loop() {
  buttonState = digitalRead(BP);
  // check if the pushbutton is pressed. If it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    Serial.println('HIGH');
  } else {
    Serial.println('LOW');
  };
  DeltaH = analogRead(UL) - analogRead(UR);                    // Read and calculate Delta
  DeltaV = (analogRead(UL) + analogRead(UR)) / 2 - analogRead(DD);   // on two axes
  if (DeltaH > DDelta) {                                       // if Delta over range
    if (RotH > 6)
      RotH -= 5;                                               // Change angle
  } else if (DeltaH < 0 - DDelta) {
    if (RotH < 174)
      RotH += 5;
  }
  if (DeltaV > DDelta) {
    if (RotV > 6)
      RotV -= 5;
  } else if (DeltaV < 0 - DDelta) {
    if (RotV < 174)
      RotV += 5;
  }
  ServoV.write(RotV);                                          // Rotate servo
  ServoH.write(RotH);
  delay(250);                                                  // Delay for stability
}
```

Figure 12. Program

Figure 13. The final view of the completed system together with the participants and organisers

The last block of discussion summarises the event and, if possible, notes the contribution of as many participants as possible to the result. The final view of the assembled installation together with the participants and the organisers is shown in figure 13.

5. Conclusions

Over the past, a series of educational activities have been developed for high school / pre-university students focusing on practical components to gain basic knowledge of optics and photonics through assignments that students must complete and undertake supporting by SPIE, Society of Photo-Optical Instrumentation Engineers. In these actions, the concepts of photonics were used from two active areas of research at NTU "KhPI": solar energy (creation of solar cells) and electricity generation at photovoltaic power plants. These directions of research are coordinated, that is, to study the production of electricity, it is necessary, accordingly, to first create solar photovoltaic panels.

We, 5 young scientists NTU "KhPI", who are specialists in the field of photonics and optics, conversion and transmission of electrical energy, will conduct a series of classes for several groups of 15 high school / pre-university students. This allowed children to become familiar with important practices in scientific research, such as: using other people's experiments to their advantage, proposing and testing valid hypotheses, persistence in understanding and solving a problem, and, finally, the desire to improve working solutions.

The basic principles and structure of these educational activities were aimed at involving High school/Pre-university students and developing their interest in the field of optics and photonics, namely photovoltaics.

The desire to develop energy storage systems for the operation of photovoltaic power plants, as well as discussion of the results, experiments. Schoolchildren were involved in absolutely all stages of the creation of these structures.

6. Acknowledgements

This work was supported by the SPIE Education Outreach Grant in 2020.

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IT-Based Visualization in Educating Hearing Impaired Learners

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Abstract. The paper continues to explore the potential of information technology which greatly expand opportunities to learn and develop for hearing impaired students and schoolchildren in a context of inclusive education. Examples are given on how simulation of biological phenomena and medical procedures, visualization of solving mathematical problems, and mobile applications can be used in a classroom and beyond. Benefits of educational activities n informal environment like museums are addressed. Maximum in-site visual support has proven to be effective.

Keywords. Inclusive Education, Hearing Impairment, Simulation, Information Technology, Visualization.

1. Introduction

The assistance of a sign language interpreter is a traditional method of supporting the educational process when working with students and schoolchildren with hearing impairments. Concurrently, the potential of information technology (IT) have been increasingly used recently. It is becoming increasingly difficult to deny or ignore the global presence of technology and the important role it plays in contemporary society. In education in particular, technology has fundamentally changed the methods teachers use in a classroom and the way students perceive knowledge.

Hearing impaired persons primarily perceive their environment visually, therefore communication with such students and their learning capacity can be significantly improved by creating a visualilly rich learning environment using IT tools. Examples include numerous applications for speech-to-text converting (Speech Texter, Voice Dictation, others) and inserting subtitles to video materials automatically on the YouTube platform or using applications (VideoShow, InShot, etc.) [1]. All today software tools, in particular simulation applications, have a graphical user interface. In this case, the user interacts with the system at the level of visual information and intuition seems to indicate how the system would respond to the user's actions. Some examples are discussed in the following sections.

2. WolframAlpha

If you look at the Wolfram Alpha main page (www.wolframalpha.com), you can see that this online tool supports learning activities across virtually every field of science, technology and knowledge as a whole. Like Google, a search engine, this tool can answer many questions, but being a computational engine, it works in a different way. Actually, Google just takes keywords gived by a user and returns links to data in other sites. In contrast, Wolfram Alpha would try to intepret what you write, using even your natural language. WolframAlpha doesn't scan the Internet for solutions. Instead, it relies on databases and content entered, tagged and cataloged by Wolfram research staff. Thus, WolframAlpha is designed as a research, but not search, tool to get a factually correct answer to users' questions, along with a visual interpretation of that answer. Again, visualization of answers is critical to hearing impaired students.

Another important feature is that WolframAlpha can answer mathematical equations which Google cannot. Mathematics is important in itself as a fundamental discipline. But it is also an analytical tool for simulating phenomena and processes in other fields of science and technology.

For example, a pharmacokinetic model has the form of a differential equation [2]. The model is designed to determine the conditions for optimal dosage of drugs, ways and frequency of administration, which would provide a sufficient therapeutic effect with minimal adverse effects. It takes into account the influence of such parameters as blood volume, drug delivery rate into the body and conditions for reaching a constant concentration of the drug in the blood. Fig. 1 shows the time dependence of the drug concentration in the blood for different values of blood volume.

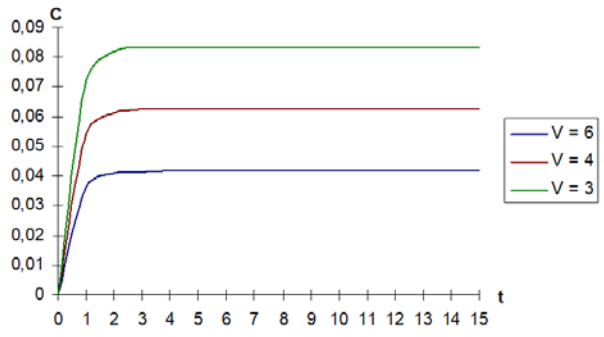


Figure 1. The drug concentration in the blood vs time for different values of blood volume

3. Simulation of telemedicine

Today, a teacher has to make a choice among numerous software products designed for various academic subjects, in which various teaching methods are implemented. Simulation is one of them. Simulation software allows educators to teach students through a virtual experience. For example, medical students can use the "Telemedicine" interactive software developed at the National Medical University in Ternopil (Ukraine) to gain experience with telemedicine procedures in health care.

The "Telemedicine" application provides data on theoretical background of telemedicine and reference materials on communication options, telemedicine devices and procedures. "Telemedicine" functionality allows students to study the hierarchy of telemedicine centers (Fig. 2), the sequence of steps in the course of remote consultation and responsibilities of its participants (Fig. 3).

Figure 2. The hierarchy of telemedicine centers

Figure 3. Remote consultation: equioment, participants and interaction

In the following activity windows, the student must click the correct structure element to answer the question displayed at the top of the screen. For example, Fig. 4 shows the question about a client workstation.

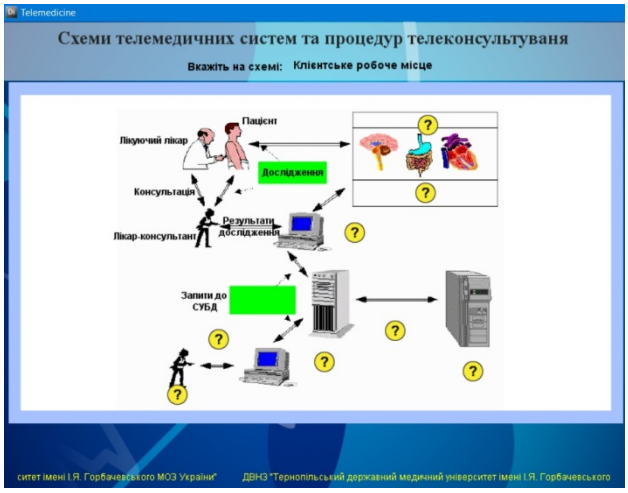


Figure 4. Show, where is a client workplace?

Finally, a message is displayed about the successful completion of the task and a number of mistakes made, that can serve as a grading criterion.

Then a student can proceed to the tasks in the core program section - "Building a telemedicine system". Here (Fig. 5) various clinical scenarios are offered (on the top), and a relevant system of remote care should be designed using components displayed in the acivity screen (at the bottom).

"Correctly!" message is displayed after the problem has been solved (Fig. 6), and the

student is offered to proceed to another, more difficult, clinical case. The number of solved cases can serve as a criterion for assessing academic performance.

Figure 5. Activity window for building a remote care system

Figure 6. Successful completion of the task

Interactive learning has proven itself as a powerful teaching method, and modern technology allows extending the learning environment beyond the classroom. Instructional software integrates multimedia content and provides users with a high level of interactivity. These two features mark off simulation from traditional teaching methods. Multimedia content such as graphics and images greatly enhances the visualization of educational materials.

4. Simulation tools in medical education

Simulation-based learning is considered an important part of the hands-on training for future healthcare professionals. This active educational process is being implemented in medical educational institutions to overcome the problems that arise when a real patient is involved in education, such as ethical and legal rights, the lack of critical events that are a pre-requisite for the acquisition of knowledge and skills.

Simulation-based medical education traditionally takes place in simulation centers. They have demonstrated the benefits of creating a patient care context with the ability to implement new technologies such as augmented reality. The development of a virtual standardized patient (VSP) has become a true need as an alternative to a real standardized patient (actor) for teaching and assessing students' skills.

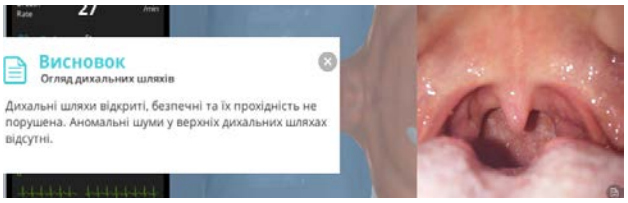
The VSP design is an integration of various technologies that form a programmable system for reproducing emotions and behavior, facial expression and lip reactions, natural language processing to simulate communication between the patient and the doctor. In addition, some advanced simulators provide a patient history, real interactive physiological response displayed in 3D scenarios, and realistic physical examination records. The VSP model is considered a useful, versatile and reproducible instructional tool with many virtual scenarios. Some of these software tools are listed below:

- Full Code - Emergency Medicine Simulation (https://full-code.com) – offers to solve severe clinical cases in a realistic 3D emergency room;
- InSimu Patient - Diagnose Virtual Clinical Cases (https://insimu.com) – a tool for thorough verification of diagnostic skills;
- Medcases - Diagnose Virtual Patient (https://medcases.io) – helps students improve their skills in examining a patient, offers a progressive algorithm of patient examination;
- Body Interact (https://bodyinteract.com) – reproduces the real physiological algorithm and the patient's health condition in real time, provides real feedback and immediate assessment of the student's actions.

When analyzing a clinical case with the help of Body Interact, the student performs a certain sequence of actions. Examples would include the following:

- input of data on a patient;

- initial examination of a patient;



- dialogue with the patient to find out the details of health status (current symptoms, comorbidities, medications taken, risk factors, etc.);
- diagnosis, which includes a number of tests, for example - coagulation tests; shown below;

Коагуляційні проби

Аналіз	Результат	Одиниці	Референтний інтервал
АЧТЧ	30	s	28 - 38
Протромбіновий час	16	s	9.5 - 13.8
МНВ	1.5	-	0.8 - 1.2
Протромбин	62	%	70 - 130
D-димер	0.2	µg/mL	< 0.5
Фібриноген	226	мг/дл	150 - 350

- treatment strategy.

Upon completing the task, Body Interact generates an evaluation message regarding how successful are actions performed by the student.

5. Mobile devices and 3D applications

Often technology is used as a direct substitute for other low-tech tools (e.g., printed handouts, moulages, replicas, samples of natural materials and substances etc.). This approach has some benefits, however only proper use of IT tools would modify or redefine learning. This is true whether we are speaking of classroom activities, or of educational events in informal environments like, for example, science museums [3].

So, gadgets and, in particular, a smartphone are an integral part of the life of children today. Since childhood, such a gadget is always at hand, and it is very important for children with hearing impairments, since it is a tool of communication between peers and a kind of socialization. Therefore, it is reasonable to use a smartphone and its instructional capabilities. Analyzing the PlayMarket service, you can see that it contains many free applications to study biology, anatomy and other science subjects. It is these applications that visualize information and develop the subject and life competencies of students.

The names of most applications give a fairly complete picture of their functionality. Examples are *Anatomy 3D Bones and Organs*, *Animal 4D+, Zoology Quiz, Plants Quiz*. Any plant is easy to recognize with *PlantNet* application that interacts with an extensive database. Moreover, it is updated by the users themselves.

Thus, the above applications make learning science more realistic for students with hearing impairments. They attract students' attention, encourage them to study science, create an atmosphere of comfortable learning, allow acquiring knowledge and skills independently and promote close social ties between the student and the teacher, the student and classmates.

6. Conclusions

Historically, computer hardware and software (laptops, mobile devices, the Internet, etc.) have greatly influenced the lives of students, especially those with disabilities. They have played an important role not only as tools to facilitate access to information, but also have a positive impact on the educational,

social, emotional and behavioral aspects of the lives of students with hearing impairments. Thus, information technology tools in combination with traditional methods of organizing the educational process provide a more complete implementation of the inclusive education model for hearing-impaired or deaf schoolchildren and students.

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Humanities, Science and Teaching. The Case of Vowels of the Portuguese Language

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Abstract. In the organisation of Knowledge, Humanities are in the antipodes of Sciences and this is verified in the structuring of teaching in disciplines, at the various levels of education, in Portugal and other countries. The follow-up of the program's classes in TV format ESTUDO IN CASA (RTP-Memória) has proven this, regarding the Portuguese language. Distance learning due to the Covid-19 pandemic (2020-2021) proves that the teaching of the mother tongue is still very focused on literature and away from science. As the literary text is fundamental for the learning of a language, it is, however, essential to encourage other parallel approaches that include the scientific text. Students rarely contact with old Portuguese texts, manifesting widespread lack of knowledge about their own language. The particular case of Portuguese vocalism is presented here.

Keywords. Humanities, Science, Linguistics, Portuguese Teaching, Vocals.

1. Humanities, Science and Teaching

The organisation of human knowledge – and multiple publications in this regard, refer, for instance, some of João Caraça [1-2] – was subdivided for several reasons. One of them is partly due to the need to deepen knowledge and, consequently, to specialisation. To be able to teach, the knowledge was implemented divided into disciplines, in which, for a long time, having also certain intermediate possibilities, such as the Arts, two large blocks oppose each other [3]. On the one hand, there are Humanities, for a long time identified as Letters, a designation that exists in some faculties in the university universe. On the other hand, there are sciences, also with their own faculties, depending on the subject they study.

This opposition is flagrant, for example, in the segmentation of school paths in the 10th grade (10º), in the Portuguese educational system, in which the student has to decide which area he "wants to go to". Those who are left without a clear notion of what to do follow Humanities and do so often without conviction, but just because they "do not like" (do not know or do not understand) Mathematics, Physics, Chemistry, Biology, or other subjects. They focus on ideas that are propagating and which are repeatedly heard in this kind of formulations: "I don't like" or "I don't know." In the opinions that they express, only these areas, sciences, require intensive and systematic study, having "lack of bases" (mainly Mathematics) or "do not like" and go to the other block, the opposite, the one in which Mathematics is not. They think that, in Humanities, teaching is not so demanding, nor so specific, requiring, therefore, great study. It will suffice, in the opinions collected, to "read a few things", some books, some texts, which often do not even get to read, merely having heard or consulting explanatory texts on literary works, which are then subject to examination. From this point of view, in Humanities, science has no place and this argument is, if analysed to a large extent, inappropriate. It is considered indispensable to have a scientific view, in any discipline of Humanities: the acquisition of knowledge implies methodological observation and reflection on the material to be studied. Train careful observation; Collect material; To describe and analyse are essential procedures. Studying a subject requires method, a scientific one, so that the study can be carried out properly.

For instance, in Linguistics, a field of Humanities, a scientific point of view is indispensable. It is true that this discipline, due to its specificities, could be inscribed in the sphere of Sciences, with Phonetics, as an example, interconnects with Physics (Acoustic Phonetics), but it is within the scope of Humanities and this should not constitute any problem. Moreover, the scientific text published for centuries may constitute study material, including the language itself, and therefore it can be the target of linguistic study.

Even today, in contact with students who move from secondary to university, the mentality of young people is the one described. Consequently, rare are those who have heard of this discipline, reducing Portuguese to literature or grammar. The latter do not appreciate it because they relate it to loosen

and punctual content (verbs, grammatical functions, types of sentences, etc.), not having a great sense of its usefulness or importance. They link it to a nomenclature (oblique complement, homograph words, homophone words, etc.), without understanding its relevance. In twenty-two years of university education, in several curricular units, less than five students revealed that they liked grammar when asked the question.

Over several academic years, in the first classes with the students who finished Secondary Education in the area of Humanities, a diagnostic test has been applied in Introduction to Portuguese Linguistics (1st year, 1st semester, Culture Studies) [4]. One of the questions focuses on "What is Linguistics?" It is intended to try to explain, succinctly, what this area of human knowledge consists of: "the scientific study of language" (says any dictionary). Almost all do not know, never heard or talked about it, but some give an answer.

Table 1. Examples of some answers

"A Linguística é estudada principalmente em universidades e por filósofos."	"Linguistics is studied mainly in universities and by philosophers."
"A Linguística é a forma como falamos."	""Linguistics is the way we talk."
"A Linguística é a parte da Língua Portuguesa que estuda a sua gramática."	"Linguistics is the part of the Portuguese language that studies its grammar."
"A Linguística é uma forma de corecção da língua portuguesa."	"Linguistics is a correct form of the Portuguese language."

Being a discipline that emerged "officially" at the beginning of the nineteenth century, with Ferdinand de Saussure [5], one would think that it had already made its way, having some reach in the educational system, including in Humanities. This does not seem to be the case. The scientific area that studies verbal language is forgotten, overlapping the teaching of literature (under the identification of Portuguese/Portuguese language) or, linking with it, foreign languages (second languages or non-native languages). When one thinks about the situation, the problem has to gain dimension for a paradigm shift.

The purpose of teaching, to a large extent, is not to allow the knowledge acquired over the centuries by Humanity to be lost. It is transmitted, in order to give it to the new generations, so that, individually, each young person can carry out his training path and contribute to the increase of knowledge. The school forms and conveys content. One should be concerned about the knowledge that children acquire. It would therefore be important to train to understand, for example, the mother tongue itself. For this, science is indispensable and this has not been verified.

The follow-up of the program's classes in TV format ESTUDO EM CASA (STUDY AT HOME), promoted by the Ministry of Education, in connection with RTP, on the channel RTP-Memória, in 2020-2021, at the critical Covid-19 pandemic period, has proved this in relation to the Portuguese language. In Portugal, in the 1st Cycle of Basic Education, when the initial approach to the teaching of writing is made, it is the Latin alphabet that will be learned and, with it, a difference will arise between vowels and consonants that does not correspond to the linguistic reality of the Portuguese language. In fact, this learning is the same for the best-known Romance languages – Castilian, French and Italian – but not all have the same vowels as Portuguese, although the alphabet they use has the same vowel letters. When asking any educated person whose mother tongue is Portuguese: "How many vowels this language has?", the answer is practically invariable. There are 5 vowels in the Portuguese language. When asking to be identified, the result is always the same: A, E, I, O, U. It is assumed that, if inquired, the population as a whole, unless having some mastery of linguistic content, will give the same answer. It reveals generalised ignorance due to lack of scientific knowledge.

2. The current situation: The case of vowels

This situation, which has long been in place, begins with literacy. It means that the teaching of writing removes from the learner the ability to think that a language, whatever it is, before being written is spoken [6] and that the vowels are phonetic elements (phones, sounds), before being phonemes, letters and graphemes. It is true that, in the first years of schooling, children are taught the LETTER-PHONE or phoneme relations, but what will overlap is the letter, passing the sound unit to the background (Fig. 1). There is even an almost total loss of the importance of linguistic analysis as a function of speech, orality,

because spelling will occupy the main place. Therefore, for example, the letter <o> will reduce all phonetic-phonological possibilities to one element only (Fig. 1). Writing is the great discovery of the literacy phase that takes place over the 4 years of the 1st cycle of Basic Education [7]. However, it should not lead to oblivion of the value of speech, as an oral aspect.

Figure 1. The <o> in A Magia da Leitura: Cartões Fonomínicos, pp. 13-14

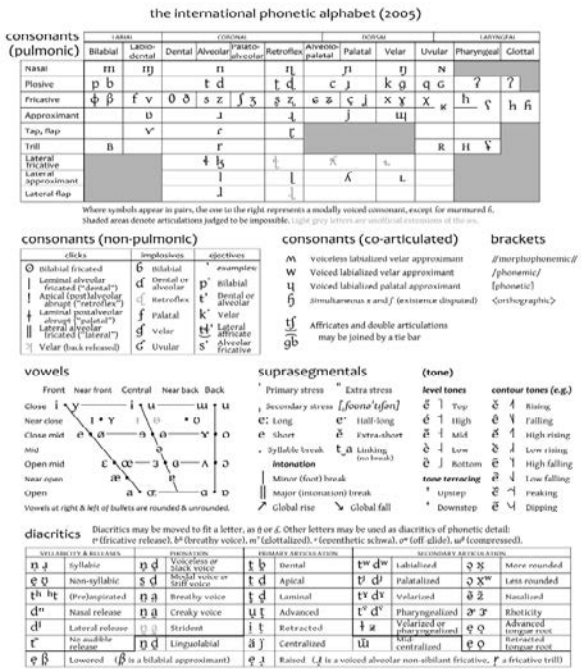


Figura 2. API, 2005

Progressively, learning causes the language to be reduced to writing. At the university level, in Introduction to Portuguese Linguistics, the opposite path is followed, going from writing to the orality of the language. It has been observed that students reveal difficulties, for example, with phonetic transcription, after having been taught the foundations and given the rudimentary instruments, which they completely ignored. They are taught to represent the symbols of the International Phonetic Alphabet (Fig. 2, API, 2005) used in the mother tongue (Fig. 3, Veloso, 1999 [8]) and reveal strangeness at the need for an intensive and systematic study of Portuguese, which they had never done. It is often said in the media that young people have difficulties in writing because they adapt it to orality. Well, that is not the case. For example, <k> is a letter that, although existing in the alphabet, is not usual in Portuguese, but is used in short messages such as SMS. By coincidence, it is an API symbol to represent phonetically spellings with <c>, in the context <+ a/o/u>, or <qu>. Now, in phonetic transcriptions, especially the full name itself, students cannot present it because they remain too focused on the written representation of linguistic segments.

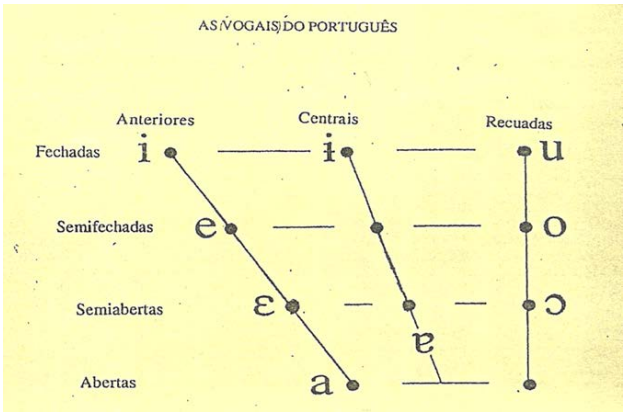


Figure 3. Veloso, 1999, Portuguese vowels of PE

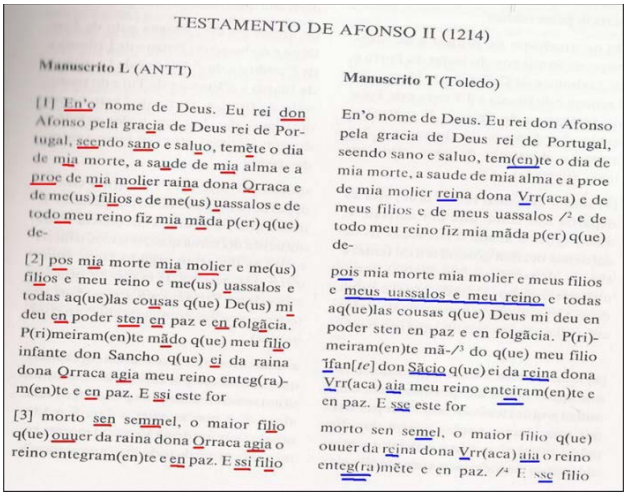
Learning that phonetic symbols and their classification are essential for studying pronunciations is something that requires scientific knowledge, within Humanities and young people do not seem to be awake to this reality. It is explained to them that Portuguese, considered European Portuguese (PE), does not have 5 vowels (oral and, therefore, will be more if the nasals are considered), but 9, being represented in an acoustic triangle (Fig. 3). This is the case if only the oral vowels of the standard variety of the language are accounted for, as there are more oral achievements at the level of the regional varieties. The Azores is an example, as observed in the studies of Clara Rolão Bernardo [9-10]. For the Azorean geographic area, she addressed the regional variety and schooling of young people from São

Miguel, dealing with the relationship between the norm and regional particularities. Even without accounting for the variation, the 5 letters of the Latin alphabet identified as vowels (A, E, I, O, U) do not account for all the vowels (phones) of Portuguese, namely European Portuguese, the one that is supposed to be taught in school so that all members of the linguistic community can understand each other when speaking. What to do to change the present state of present situation? How can we include a scientific dimension in the area of Humanities, especially in the teaching of the mother tongue? Why is it not studied, for example, the scientific text, in the discipline of Portuguese [3], in the teaching system?

3. The desired situation: The case of vowels

Students who arrive at the University to attend courses in which there are curricular units linked to Linguistics (until then, in secondary education, the designations, as we saw, were Portuguese or Portuguese Language), especially of Humanities, never had contact with old texts written in the original way. If they had, they don't keep any memories of it, they can't even approach it. When they're given some, they're intrigued. They didn't even think there were texts on the language in the past. As for the initial reference, to the "birth" of the language, that is, to the remarkable moment of the History of the Language that consists of the first official text, of the thirteenth century, they do not have the slightest notion that it is a Testament of King Afonso II. The comparison of excerpts to compare similar and different linguistic units in the two specimens of the will (Fig. 4) that lasted in time and which Ivo Castro [11] transcribes is an exercise of observation and description, which is unique because it consists of a discovery. Until then, they were used to looking at the text to look for characters or other elements of literary analysis, such as the narrator, the time of narration, etc. This analysis is also valid, but cannot be exclusive, regarding the study of language. It is important to intensify the look at the linguistic units of the text in order to study the language itself. Here, it's about getting to orality through writing.

It is interesting, for example, to see how they react when they are given a sample of the first grammar, which is from the sixteenth century (Fig. 5). Fernão de Oliveira was the first grammarian of the Portuguese language [12], a work regarded as descriptive. It would deserve some attention during the course of teaching in successive years of schooling. However, it is completely ignored. No student in the field of Humanities has ever heard of him or his grammar.



TESTAMENTO DE AFONSO II (1214)

Manuscrito L (ANTT)

[1] En'o nome de Deus. Eu rei don Afonso pela gracia de Deus rei de Portugal, seendo sano e saluo, temẽte o dia de mia morte, a saude de mia alma e a proe de mia molier raina dona Orraca e de me(us) filios e de me(us) uassalos e de todo meu reino fiz mia mãda p(er) q(ue) de-

[2] pos mia morte mia molier e me(us) filios e meu reino e me(us) uassalos e todas aq(ue)las cousas q(ue) De(us) mi deu en poder sten en paz e en folgãcia. P(ri)meiram(en)te mãdo q(ue) meu filio infante don Sancho q(ue) ei da raina dona Orraca agia meu reino enteg(ra)-m(en)te e en paz. E ssi este for

[3] morto sen semmel, o maior filio q(ue) ouuer da raina dona Orraca agia o reino entegram(en)te e en paz. E ssi filio

Manuscrito T (Toledo)

En'o nome de Deus. Eu rei don Afonso pela gracia de Deus rei de Portugal, seendo sano e saluo, tem(en)te o dia de mia morte, a saude de mia alma e a proe de mia molier reina dona Vrr(aca) e de meus filios e de meus uassalos /[2] e de todo meu reino fiz mia mãda p(er) q(ue) de-

pois mia morte mia molier e meus filios e meus uassalos e meu reino e todas aq(ue)las cousas q(ue) Deus mi deu en poder sten en paz e en folgãcia. P(ri)-meiram(en)te mã-/[3] do q(ue) meu filio Ifan[te] don Sãcio q(ue) ei da reina dona Vrr(aca) aia meu reino enteiram(en)te e en paz. E sse este for

morto sen semel, o maior filio q(ue) ouuer da reina dona Vrr(aca) aia o reino enteg(ra)mẽte e en paz. /[4] E sse filio

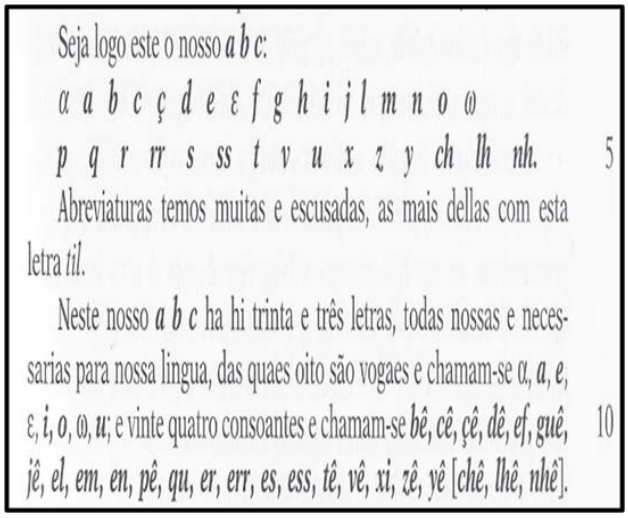
Figure 4. Comparison of the two copies of Testament of King Afonso II (Castro, 1991)

Figure 5. 1536, Grammatica da Lingoagem Portuguesa, Fernão de Oliveira

The author made a survey of the characteristics of the language of his time. When providing the letters of Portuguese, in 1536, the grammarian presents different symbols for A, E and O. On the page referring to the alphabet, it is observed that Fernão de Oliveira includes letters that are not in the Latin alphabet for vowels. Thus, it appears that two arise for what is usually identified with A, another two for E and again two for O. Only I

and U hold a letter. In large part, with this description of the first Portuguese grammarian, it is concluded that, orally, in the sixteenth century the Portuguese oral vowels were not 5. He counts 8 (Fig. 6) and, today, 9 are identified (Fig. 3). It would be interesting to think about this changing and Science could help to do that, at school.

One might think that a text like this would be essential for those students who study their mother tongue. They should know the history or study it with some criterion to understand it, since they use it daily. Actually, it's not like that. It turns out that it is a bit like using something far-fetched, without an instruction manual, using only general guidelines. The same happens with university students in the area of Humanities.



Seja logo este o nosso *a b c*:

a a b c ç d e ɛ f g h i j l m n o ω

p q r rr s ss t v u x z y ch lh nh. 5

Abreviaturas temos muitas e escusadas, as mais dellas com esta letra *til*.

Neste nosso *a b c* ha hi trinta e três letras, todas nossas e necessarias para nossa lingua, das quaes oito são vogaes e chamam-se *a, a, e, ɛ, i, o, ω, u*; e vinte quatro consoantes e chamam-se *bê, cê, çê, dê, ef, guê,* 10 *jê, el, em, en, pê, qu, er, err, es, ess, tê, vê, xi, zê, yê [chê, lhê, nhê].*

Figure 6 The Portuguese alphabet by Fernão de Oliveira

It is considered essential to change attitudes, changing the paradigm. Humanities, especially the area of the mother tongue, need to be deepened. It must require students to carry out intensive study of various subjects, as it is the case in the field of science. Until this happens, the teaching of Portuguese will always be seen as that of the discipline where only the reading of literary works is required for cultural reflection on the world, which is also valid, but should not be exclusive. The study of languages presupposes more specific knowledge. Only in this way can you get different answers to the question: How many vowels has the Portuguese language? It is right and well known that there are not only five. Linguistics has to appear in teaching because it is an integral part of Humanities. This is the desired situation.

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Introducing Programming to Basic Schools Students Using Robotics

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Abstract. The present work reports on the development of programming activities with students from the 1st and 2nd cycles of schools in the town of Braga in the northwestern Portuguese region of Minho. These activities of promotion of computer programming were applied in order to promote the programming and innovative practices on science and technology education. The explored interdisciplinary methodologies in STEM teaching-learning processes, stimulate critical thinking and creativity while promoting the benefits of learning in collaborative environments.

The active involvement of the students in these robot programming, "high tech" and trendy, activities is easy to achieve if the proposed challenges are set at an adequate level of difficulty and appealing enough to the age group and level of cognitive development of the student. Whenever possible to the students is given the possibility of chosing or even defining the problem/subjet they will be exploring by programming a robot, which is seen as a mechanical artificial being the students will be able to understand, interact with and use and control.

The teacher/educator should be available to provide to the students a proper empowering environment and to provide all support requested by the students giving, as much as possible, not straight answers but yes clues and small hints and examples leading the students to reach, themselves, to a solution to the problem the students face or to an answer to the students' question that satisfy their own critical judgment.

Through the programming testing process, it is possible to verify and see the level of perception and proficiency of the students assessing what students have learned and accomplished, creating immediate feedback for students and adjusting or re-orienting the students' focus on a particular task or reasoning process.

If well succeeded these activities can develop among the students a sound appreaciation towards Science Technology and Engineering while establishing relevant knowledge, creativity critical reasoning abilities and a large number of other competencies that will be valuable for the future development of the students in their studies and academic life but also in their future careers.

The improvement of the self-esteem of the students when they realize they can actualy "do it" is also a major benefit of this type of activities. As well in what concerns the boost of the self-esteem and selft-appreaciation of their teachers and educators, that often fear to explore this type of innovative approaches.

Keywords. Programming, STEM, Robotics, Hands-on, Creativity.

1. Introduction

The teaching of programming is being a clear concern for the implementation of educational measures, as one of the fundamental skills for living in the 21st century.

Automation and robot programming are increasingly important in our modern societies and exploring ways to introduce it in the formal and or informal and non formal education is being done for several years [1-5].

Constructivist, inquiry based, problem solving, hands-on and other student centred active pedagogic approaches are being extensively and successfully used in science and STEM education including at early ages [6].

The introduction of robotics as "tool" in the process of learning the basics of science and technology in basic schools or even at pre-school level is also being tried with success in different approaches [2-5].

2. Educational Robot Programming

Gonçalves and Freire in 2012 defined robotic programming in education by saying it can be characterized as "a work environment,

where students have the opportunity to assemble and program their own robot, controlling it through a computer with specialized software. The student becomes a builder of knowledge, through observation, practice itself and the collaborative work that arises between teachers and students" [5].

Figure 1. The NXT Smart Brick of the Mindstorms NXT 2.0 LEGO robotics kits

Experimental studies indicate that learning processes based on problem solving, using programming logic, show an increase in brain areas, reasoning ability and concentration of students [7].

Different robots and programming languages exists are being used with pedagogic purposes [1,4]. Among those LEGO Mindstorm [8-9] became particularly popular are extensively used.

For the work herein reported Mindstorms NXT 2.0 Lego's robotics kits were used. The CPU of the NXT 2.0 robot, the central element of the robot, is the NXT Smart Brick (Fig. 1) with an ARM7 microcontroller already successfully tested for years with RCX (Robotic Commander Explorer) centrals. The new control brick have upgrades that allow the use some of the current technologies, such as Bluetooth connections. It has a 32-bit ARM7 Microprocessor, with 256 kb of memory; USB 2.0 port; 4 input ports; 3 output ports; a 100 x 64 pixel LCD monitor, a speaker and a rechargeable battery.

Sensors and actuators are connected to the central block of the NXT Smart Brick, the 4-Port (input), with RJ12 inputs. Ports A, B or C (output) can be used with RJ12 cables connected to 3 servo motors. For graphical programming, it is possible to use the native environment that comes with LEGO Mindstorms NXT 2.0 robot kit, called the NXT-G language. Alternatively other programming platforms such as Java (leJOS), Python (NXT-Python) or C (NXC) can be used. ADA (GNAT GPL), Forth (pbFORTH), Lua (pbLua) and Visual basic (using COM+ resources), can also be used requiring a replacement of the original firmware provided by LEGO Mindstorms, with the firmware of the desired platform.

For young students graphical programming is far easier and more adequate (Fig. 2). The use of the NXT graphical programming tool appeals to the young students with its commands, simple or more advances, represented by graphical blocks that the student will place on the programming board connected in a proper sequential way.

Figure 2. 1st grade classroom discussion of the programming of a robot

3. Implementation

The robot programming activites were performed at two 1st and 2nd cycles schools in the town of Braga in the northwestern Portuguese region of Minho, Externato Paulo VI school (first cycle) and André Soares School Group (second cycle).

The study took place in the school years 2018/2019, 2019/2020 and 2020/2021 and involved students 7 to 11 years old. The activities were carried out using four NXT 2.0 robot kits provided by the Associação Hands-on Science Network. Different programming and construction activities were introduced and developed at different paces and depth levels:

- Manipulation and assembly of legos pieces in order create small objects and simple constructions as training to the building of a moving robot (or a robot with moving parts).
- Programming a robot directely from the physical interface of the NXT Smart Brick Central Block, with visualization on the existing LCD.

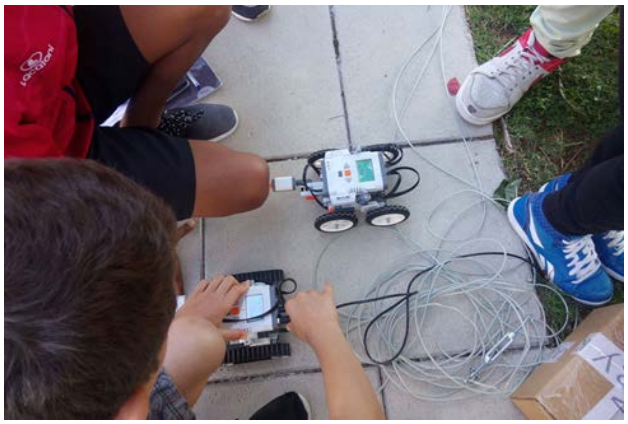

Figure 3. Transfering the program to a robot and checking the programming outcome

- Introduction to logic block programming using the graphical interface creating simple routines and commands (Fig. 3).
- Spatial location-oriented challenges
- Lateral straightforward and backward movement simulation challenges making the robots to make left turns, to turn right, and to move backward and forward reversing motion.
- Development of tasks to follow a path or route drawn in the floor of the classroom, in which students would program their robots in order to make them travel from one point of the room to another point following a particular route, more or less complicated. These challenges were carried out in small groups. Students would have to estimate the number of turns that the wheels would have to make (addressing the notion of perimeter for students in the 2nd cycle) in order to go from departure point to the point of arrival.
- To program a robot to run a course in a runway filled with obstacles that the robot must contour.
- Study of the drawing of quadrilaterals exploring the problem of the robot performing a partial rotation (notion of angle). In the same line to solve the challenge of the construction of triangles exploring the concept of internal and external angles (Fig. 5).

Figure 4. Using different sizes or types of "wheels" may demand adjusts to be done to the programming of the robot

Figure 5. Exploring the notion of angles with robot rotation adjustment

4. Conclusions

Activities involving programming and robotics, in project-based learning, allow students to develop skills for the century XXI. As well they can be used to stimulate the interest and skills in STEM (Science, Technology, Engineering and Mathematics).

The use of these technological tools in the learning environment, particularly in interdisciplinary processes, can be very useful and should be taken into account also in teacher training.

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MaiActing, Portugal Changing! A Climate Action Project in an 8th Grade CLIL Class

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Abstract. One of the 17 goals for Sustainable Development is to take urgent action to combat climate change and its impacts. Having in mind the need for students to acquire the knowledge, skills, values and the attitudes they need to build a green, low emission and climate-resilient future, students from the 8th grade CLIL class of Agrupamento de Escolas da Maia participated in the Climate Action Project. This Project is supported by Dr. Jane Goodall, UN Foundation and many world leaders and allows students to collaborate on global scale on climate change topics. Students explored concepts, brainstormed ideas, discussed causes and effects, created solutions (using APPs like Padlet, Powtoon, GoConqr, Coggle and Popplet) and shared their work with youngsters from the six continents. The activities were done in the English, Natural Sciences and Combined Physics and Chemistry classes as part of an interdisciplinary work.

Keywords. Climate Change, Collaborative Work, Critical Thinking, Digital Competences.

1. Contextualization

Currently, it is considered that the pedagogical approaches to be implemented in the classroom should be student-centered and applied to real life in order to promote meaningful learning. Interdisciplinary projects are also extremely important as they allow students to acquire the 21st century skills.

The integrated learning of curricular content and language, through bilingual teaching approaches and / or Content and Language Integrated Learning (CLIL), has been recommended by the European Commission as one of the most effective ways of learning a Foreign Language (FL). In this context, a pilot experiment was developed in the School Cluster of Maia, which is part of the Bilingual Schools Programme, including the subjects of English, Natural Science and Combined Physics and Chemistry. The objective is to use the English language to teach content and, therefore, some content classes are taught in English, and involve a very strong practical component, through projects and experimental work in order to provide students with 21st century skills.

CLIL classes are, par excellence, a way of promoting collaborative tasks and interdisciplinary projects [1]. During these classes, students have the opportunity to use new learning methodologies, to promote collaborative work and to equip themselves with the tools and working methods required in the real world.

Several studies show that learners prefer to use technology, rather than more traditional materials [2], and that it promotes an important dynamic in the classroom, enabling a variety of activities / tasks that respond to different learning profiles.

2. Introduction

The World Meteorological Organization (WMO) claims that concentrations of carbon dioxide, methane and nitrous oxide (greenhouse gases) in atmosphere reached record levels in 2018 [3]. 2019 was the second warmest year since 1880, acording to NASA and the National Oceanic and Atmospheric Administration (NOAA) [4]. Therefore, it is urgent to transform society to avoid catastrophic and irreversible climate change. It is important to incorporate climate into students' undergraduate curriculums to raise awareness around the climate emergency.

Being aware of the effects of climate change in Maia and around it, and knowing that these climate changes are real and it is the students' challenge to change their lifestyle, and the lifestyle of people who live near them, students from the 8th grade, class D, from the School Cluster of Maia participated in the Climate Change Project 2021. This project aimed to use project-based learning to increase understanding and engagement with these key real-world issues, while improving problem-solving and critical thinking skills, building empathy, and fostering creativity and collaboration.

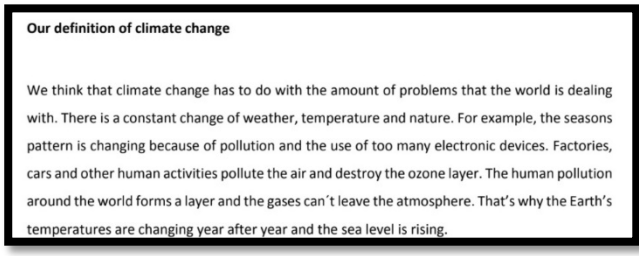
3. Methodology and results

Every week students had some questions for the week to reflect on and, after exploring possibilities, they had to present a collective action related to those questions. Each week the work done as well as a video with the actions taken, done using the APP Powtoon, were shared in the Climate Action website.

3.1. Week one

Causes of Climate Change was the topic that students started working in the first week of their project. The questions they reflected upon were: "What is your definition of climate change?"; "What causes climate change?" and "What is your personal connection to climate change? [5]".

Students started by differentiating weather from climate. Next, they created a list of trusted international and national climate change experts, examined/evaluated definitions of climate change and finally created their own definition of "climate change".



Our definition of climate change

We think that climate change has to do with the amount of problems that the world is dealing with. There is a constant change of weather, temperature and nature. For example, the seasons pattern is changing because of pollution and the use of too many electronic devices. Factories, cars and other human activities pollute the air and destroy the ozone layer. The human pollution around the world forms a layer and the gases can´t leave the atmosphere. That's why the Earth's temperatures are changing year after year and the sea level is rising.

Figure 1. Our definition of climate change

As the collective action students co-created a list of climate change causes and added them to the "Longest List of Causes" created by youth.

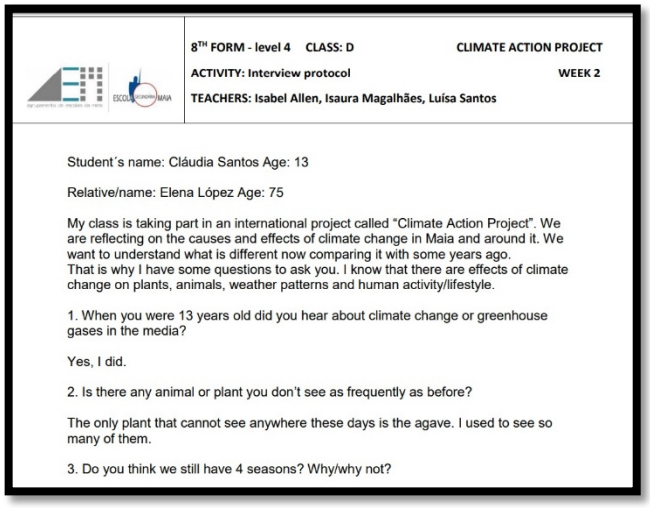
3.2. Week two

During this week**,** students worked on the "Effects of Climate Change". They had to answer the following questions: "How can I build on prior learning to connect to new ideias?"; "How is climate change impacting my local community?" and "How can accessing multiple perspectives provide new direction for action?" [5].

After reflecting on causes of climate change, students, in groups, explored the effects of climate change in their local flora, fauna (Fig. 2), weather patterns, human activity and lifestyle.

Figure 2. Birds in our school. Photograph of Carolina Lopes, 8th grade

Next, students prepared a questionnaire to interview their relatives, about "Climate Change" (Fig. 3).



8TH FORM - level 4 CLASS: D — CLIMATE ACTION PROJECT
ACTIVITY: Interview protocol — WEEK 2
TEACHERS: Isabel Allen, Isaura Magalhães, Luísa Santos

Student´s name: Cláudia Santos Age: 13

Relative/name: Elena López Age: 75

My class is taking part in an international project called "Climate Action Project". We are reflecting on the causes and effects of climate change in Maia and around it. We want to understand what is different now comparing it with some years ago.
That is why I have some questions to ask you. I know that there are effects of climate change on plants, animals, weather patterns and human activity/lifestyle.

1. When you were 13 years old did you hear about climate change or greenhouse gases in the media?

Yes, I did.

2. Is there any animal or plant you don't see as frequently as before?

The only plant that cannot see anywhere these days is the agave. I used to see so many of them.

3. Do you think we still have 4 seasons? Why/why not?

Figure 3. Interview protocol done by Cláudia Santos, student of the 8th grade, to her grandmother (aged 75)

Using the APP Powtoon, students created a video (Fig. 4), where they showed some of the effects of climate change in Portugal and around Maia.

They realised that they had to make a serious effort to change the things they found as quickly as possible.

Figure 4. Effects of climate change on Portugal and around Maia. Work done by Luz Marinho, 8th grade student [6]

3.3. Week three

Climate Action: Local to Global, was the topic of the third week. Students had to reflect on the following questions: "How can I build on prior learning to connect to new ideias?"; "What are the effects of climate change on our planet?" and "How can data be used to predict the future impact of climate change?" [5]. As a collective action, students connected online with a Turkish class. They exchanged fears, concerns, perspectives and ideas on climate change with a class in Turkey (Fig. 5).

Figure 5. Virtual exchange with a Turkish school

As a final product of this week students, made a video about the possible effects of climate change in our future (Fig. 6).

The contents, acid-base character of solutions, pH scale (Fig. 7, 8 and 9) and acid-base reactions were taught, during the implementation of the Climate Change project, in the Physics and Chemistry class and helped students better understand the topics they were working on.

Figure 6. Climate Change. Work done by Nuno Aroso, 8th grade student [7]

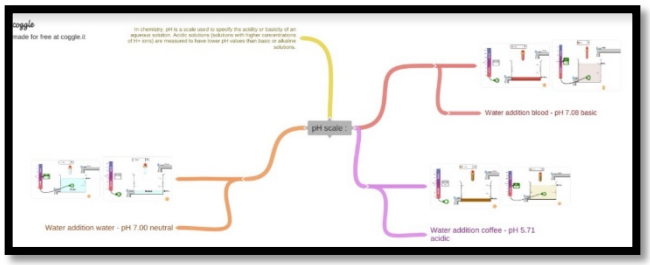


Figure 7. Mind Map Coggle: pH Scale. Work done by Marta Ramos, 8th grade student

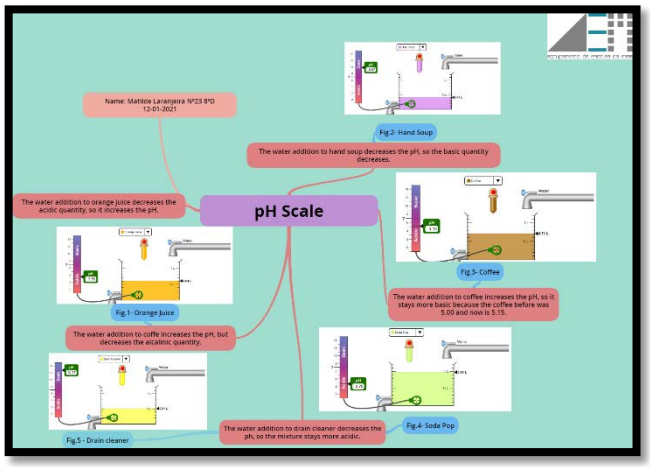


Figure 8. Mind Map GoConqr: pH Scale. Work done by Matilde Laranjeira, 8th grade student

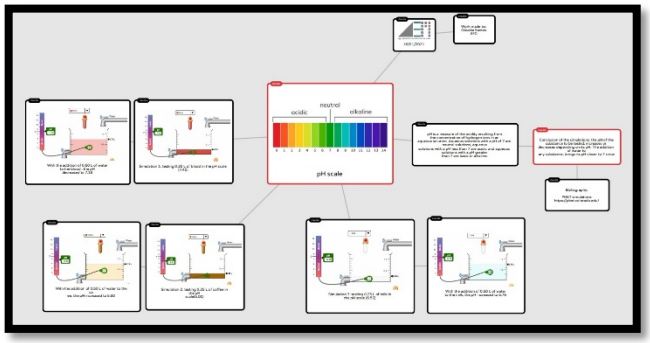


Figure 9. Mind Map Popplet: pH Scale. Work done by Cláudia Santos, 8th grade student

3.4. Week four

During this week students reflected on causes and effects of climate changes and designed solutions for the climate crisis. (Fig. 10).

The following questions were taken into account by the students: "What are actions individuals can take to adress the climate crisis?", "What are actions organizations and governments can take to adress the climate crisis?" and "How can one individual person/class design a difference through action?" [5].

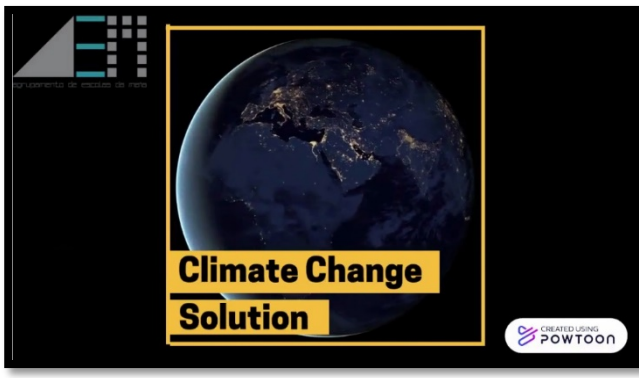


Figure 10. Climate Change Solution [8]

Figure 11. Video made by 8th grade students Cláudia Santos, Daniel Medeiros and Luz Marinho [9]

In the Natural Sciences classes, students researched alternative energies and produced short videos that reflected their research.

These themes are related to certain contents of the subject, such as the study of renewable natural resources and their exploration, as well as science and technology for sustainable development.

Figure 12. Video made by 8th grade students Maria João Ramos and Matilde Laranjeira [10]

Figure 13. Video made by 8th grade students José Fernandes, Nuno Aroso, Paulo Vieira e Rúben Oliveira [11]

3.5. Week 5

Building through Interactions was the topic of the fifth week. Students researched causes and effects of climate change and started thinking about solutions to present in the last week of this project. They continued reflecting on the previous questions and also considered a new one: "How can one individual person/class design to make a difference through action?" [5] (Fig. 14).

Figure 14. Climate Change solutions. Work done by Carolina Lopes, 8th grade student [12]

3.6. Week 6

During the final week the topic was “Climate Actions”, so students decided what they could do in their city/school to make people change their behaviours: they planted trees and bushes in their houses; they are going to plant a tree in the school as a symbol of their commitment to climate changes [5] and they organised an “Eco-Friendly Week” to make their schoolmates aware of the importance of changing their daily habits in order to protect our planet (Fig. 15).

Figure 15. Call for action: Letters done with recycled materials by students from the 8th grade, class D

During the six weeks of the project, in the English classes, students always worked all the topics in order to give support to the other two subjects involved and because they are closely related to an 8th grade unit: “Environmental problems and solutions”.

As a final call for action, the students decided to organize a week with different activities, from interactive videos (Fig. 16) to a plastic hunt (Fig. 17), a Kahoot about environmental problems and a plastic-free day, to make their colleagues aware of the priorities they should have.

Students prepared all the activities, the teachers once again acted only as facilitators in the whole process. They invited their schoolmates to explain what they had been learning and experiencing and lead them to reflect on some issues they considered more relevant.

Figure 16. Eco-Friendly Week: Interactive video about sustainability

Figure 17. Eco-Friendly Week: Plastic Hunt

Due to the pandemic situation, and in order to respect social distances, each class from school could only choose five students per day to represent it and take part in the different activities. During the five days of the week, students received points for each activity and at the end a winner was announced to the school – a class from the 10th grade (Fig. 18).

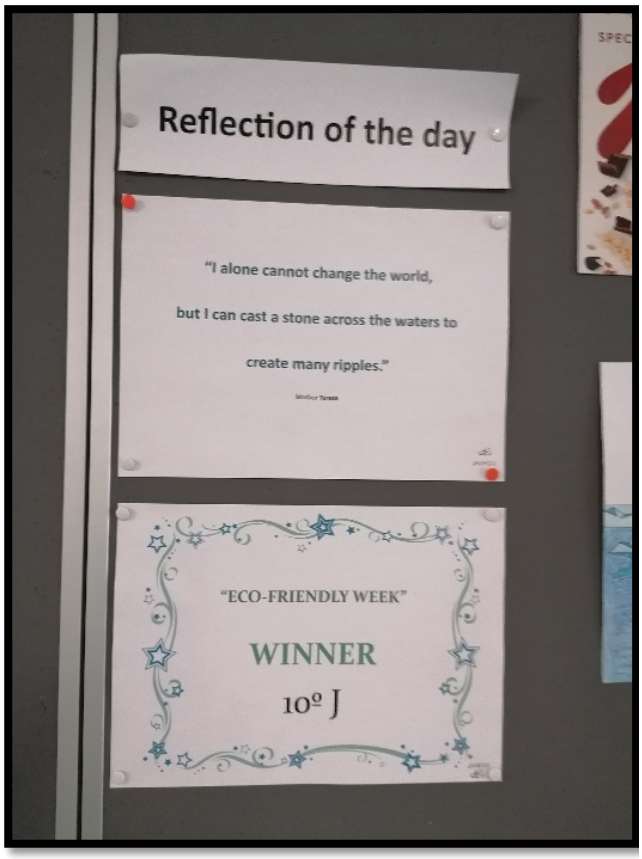


Figure 18. Eco-Friendly Week winner

To disseminate their work, the students made a small video (Fig. 19) which shows the different phases of the project.

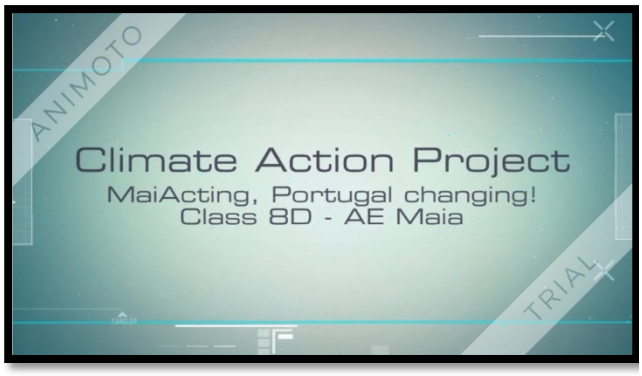


Figure 19. Final video of the project Climate Change [13]

4. Conclusions

During the activities carried out in this project, students showed commitment and interest, collaborating in a more active way. It was possible to cross-section content related to Natural Sciences, Physics and Chemistry and English. Students gained a deeper and authentic understanding about global issues, were able to raise questions, seek solutions, solve problems and took action.

The project promoted an expansion of students' scientific knowledge, developed their critical, deductive and creative thinking and fostered a taste for science. Moreover, students had the opportunity to form positive habits and values that they can carry outside of school and beyond their school life.

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SAYANSI! Seeds of Science for a Sustainable Future

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Abstract. Education is a key factor for a sustainable future, and scientific education deserves special attention. Traditional school lessons are undergoing a radical transformation but at a different rate in different countries. We presented an interactive science show for the Sustainability Festival 2020 focusing on the role of education on environmental issues, intended for an Italian audience and aimed to open a reflection on the comparison between the European countries and the sub-Saharan reality. This paper reports the design of the show and its adaptation for online version, and gives a general overview on the SeedScience Project.

Keywords. Africa, Education, Future, School, Science, SDG, Show.

1. Introduction

"Sayansi" means "science" in the Swahili language, widely spoken in East Africa and – in general – in most areas where the SeedScience Project is active [1]. Science can help us understand the world and what happens around us. Science education, therefore, is crucial to achieve the sustainable development goals towards a desirable future. The framework contest is represented by the UN 2030 Agenda and the 17 SDGs [2]. Our belief is that with a good scientific education, children and young students will grow up as smart and responsible citizens. The goal is not to teach specific and detailed scientific issues, but to make science open to everybody, to boost curiosity, and to incline to critical thinking.

Every year since 2017, ASviS – Italian Alliance for Sustainable Development promotes the Sustainable Development Festival [3] as a national program with hundreds of cultural events spread in whole Italy. The Association Apriti Scienza submitted the proposal for a science show focused on the scientific education for a sustainable future based on the experience of the SeedScience Project and intended as an opportunity for the public to reflect on the different life-style in Italy and in some African countries.

The science show "SAYANSI! Seed of science for a sustainable future" was realized in presence in fall 2020, hosted by science museums in Piedmont (Fig. 1), and later replicated for online school classes.

Figure 1. Science show at MAcA_Environmental museum in Turin

2. The interactive science show

We designed a science show of about 1,5-2 hours, intended for a mixed audience of school students ranging from 10 to 14 years old and parents. The format includes a supporting presentation, a quiz, demonstrations, a challenge, a group activity, and collective reflections. The structure is flexible and allows the explainer to adapt it to the specific audience. Here the complete structure is summarized in five main milestones.

2.1. What are we talking about?

First, we warmly welcome the participants to Africa with a bit of the most essential Swahili vocabulary and beautiful pictures, then we focus on a map of Europe and Africa asking for the first question:

How big is Tanzania?

a) Italy b) Germany c) France

As they look at the map (standard Mercator projection) the majority bet on France but when we honestly admit that the right answer was not included among the options they were surprised. Showing a Peters Map, an equal-area projection, they can't recognize the world and were astonished discovering that the right

answer should have been rather France and Germany together instead of a single country!

This is what we want to talk about. Science is about measuring, comparing, and comprehend the world, and sustainability is not an idea but rather the need to face the reality. So we invite the participants to forget what they think to know about science (what they have learned at school), about Africa and even about our own country. Things are different.

2.2. Water SDG6

The second question of the quiz concerns water:

How much water do we need for a shower?

a) 10 L b) 65 L

Both answers are correct, depending on where you live. In Tanzania, most people use a 10 L bucket to have a shower daily, whereas in Italy you may use about 65 L for a shower no longer than 5 minutes. Besides the issue of water wastefulness we want the participants to think about the importance of the right use of water for hygiene and sanitation. Anybody in Italy is well aware about hands washing (not the same among many children in Africa), but only few can give you strong arguments on the reason why it is so important. Here we propose an experimental demonstration. Four participants are involved. The first touches a piece of bread with both hands (without washing before) then the awful food that nobody would have eaten is kept safe in a Petri dish. The second one washes their hands with some water from the bucket, just like in Africa where you often don't have a sink. Then s/he takes some bread and puts it in a second Petri. The third washes the hands with soap and we get the third sample of bread. Finally, one takes the bread with lab gloves and tweezers, avoiding any contact. This is how scientists work to prove the influences of germs, bacteria, and mold. When we show the set of Petri prepared one week before, the only two uncontaminated pieces of bread prove the need to use soap and proper washing movements.

2.3. Science at school SDG4

The experiment is an example of what the SeedScience Project does in Africa, impacting society by training and supporting school teachers to adopt hans-on methodologies with their students. We present the project and the context of African schools, so that anybody can feel the difference (e.g. structure, furniture, textbooks, facilities…) but also the similarities (e.g in the gaze of a bored student): do you enjoy your science lesson? How much fun is to learn about chemistry, physics or biology? Let's try from a simple question: how can we inflate a balloon? The audience splits in small groups and works on different experiments (Fig. 2). At the end, each group presents the achieved results and tries to explain how they inflated the balloon.

Figure 2. Group activities

We briefly report the different experiments:

- [Physics] The balloon is fixed on top of a small bottle. Immersing the bottle in a large beaker with hot water will make the pressure of the air inside the bottle increase and thus inflate the balloon. Moving quickly into a cold water beaker makes the balloon deflate, due to the pressure reduction. You can repeat several times the warming-cooling cycle (reversibility).
- [Chemistry] The balloon is filled with a proper amount of baking soda; some vinegar is in a bottle. Then fix the balloon on top of the bottle and let the content fall into the liquid. In a short time you will see the balloon inflating due to

the gas production in the chemical reaction:

$CH_3COOH + NaHCO_3 \Rightarrow CH_3COONa + H_2O + CO_2$

- [Biology] The balloon is filled with a proper amount of yeast while some warm water and a bit of sugar are mixed in a bottle. Then fix the balloon on top and let the content fall into the liquid; gently move the bottle to mix the content. Unfortunately, you'll see nothing. So the group must face frustration and explain why they *do not* inflate the balloon! Of course the bio-mediated reaction needs time. But at the end of the show all the participants will see the inflated balloon. In this case the gas production depends on the reaction of fermentation.

2.4. Plastic SDG12

The plastic bottles we used for the experiments and the balloons remind us of the big problem of plastic waste. In Italy and in Africa as well, so the question is:

How many bags of plastic waste does a four people family produce in a month?

a) 1,5 bags b) 4 bags

Again, both answers are correct depending on where you live. But actually the even high production of plastic waste in Italy represents a smaller problem if compared with Africa. In Italy most of plastic waste is recycled while many people in Africa are used to burn it in some ditch in the ground, making even bigger problems of toxic contaminants in the water, the air, and the soil. Luckily, they are on the right way too! We visited a recycling factory in Morogoro (Tanzania) to observe what they do. Only plastic bottles are taken in the business, they are collected manually in town and in the villages, then grind in a machine and the plastic fragments divided (the bottle and the cap are made of different plastic polymers), finally each material is shipped for the next step of the recycling process. That's pretty similar to what happens in Italy… thanks to precise technology and machines.

Then we propose a challenge to the participants. They receive an handful of mixed plastic fragments and have only 1 minute to divide the different polymers (Fig. 3) - they can easily recognize the plastic of the bottles from the plastic of the caps by the different colors and thickness.

Even the faster who can win the challenge will admit that a more convenient strategy must be used in the recycling process, in Africa as well as in Italy. That's exactly the point where science and engineering come. Based on the different densities we can divide easily the two polymers just by putting the mix into the water; after stirring for a while the heavier plastic is at the bottom, and the lighter floats on the surface!

Figure 3. Plastic recycling challenge

2.5. Climate change SDGs13-14

Apart from waste management and plastic pollution, the undiscussed issue for the present world is facing climate change. The first step to understand the problem is to "feel" the greenhouses effect. We use an easy demonstration employing two large glass containers that have been exposed to solar rays at the beginning of the show: one was closed with a cling-film, while the other was left open. Some of the participants could put the hand into the containers and clearly feel the difference in temperature. From this experience we explain that the same effect is produced by some gasses in the atmosphere, especially CO_2, CH_4, and H_2O. If we compare the CO_2 emissions of Italy and Tanzania, as an example

for some of the African countries where SeedScience is, we can discuss the different responsibilities and find the main causes of the great difference among the different lifestyles (in 2019 Tanzanian emissions were only 4% of the Italian emissions [4]).

A mysterious object pops up: what is it?

To rise up attention and encourage curiosity in the audience, we take a mysterious object. They can see and touch it gently. It is a naked egg, the shell has been dissolved after 24 hours vinegar soak. We want to talk about a side effect of high CO_2 concentration: it dissolves into the water and increases the acidity of the oceans. Seashells and eggshell are made of similar materials and the effect of 24 hours in vinegar are less fun and more dramatic on the sea animal shell (Fig. 4).

Figure 4. Seashell after being soaked in vinegar for 24 hours

3. From stage to screen

After the events for the Sustainability Festival, in fall 2020, we offered the show for middle school students in an online version. We implemented online tools to present the size comparison of countries [5] and for the quiz [6]. This allowed to collect the answers and give a visual feedback.

In order to keep the hands-on activities, we provided the students with protocols and detailed instructions to make some experiments we didn't show in the online meeting or remake some others they like. We invite them to share a video of what they did using an online platform [7]. We did the demonstration on hygiene and show the naked egg, because of the visual outcome, but encourage them to repeat the experiments later and provided easy tutorials. On the contrary, we didn't make the greenhouse effect experiment and asked them to build their own model later - we wanted them to be focused on the concept but be creative and free on the materials and arrangement. Finally, we maintained the experiments for balloons inflating during the online meeting: we sent in advance the list of materials they have to find, then divided the class into three groups and published the procedures separately. They had a definite time to do the experiment individually and discuss with the group. Later on, a representative of each group reported the results and show the experiment to the other classmates.

We believe that hands-on activities still deserve a crucial role in the teaching-learning process in online mode. Even if cons are evident, we prefer to see the pros and bit on them to develop new strategies and formats. Overcome physical distances, and the opportunity to work with children and teachers far from the usual local reference is the first important heritage of the pandemic, together with the strong input fostering digital education at any age.

4. The SeedScience Project

The project considers education as a key factor for the sustainable development of a country. In particular, high-quality scientific education has a massive impact in developing countries if we think about nutrition, food production and storage, hygiene and diseases prevention, waste management, environment preservation, energy production, water and soil preservation.

The goal of the project consists in the training of local science teachers on different methods of teaching science subjects for 10-18 years old students. Hands-on experiments can be realized with low cost or free, often reused, materials and will help students in more engaging and deep learning of the phenomena around them. After a cohort of training, the trained teachers keep growing together and involving more and more teachers and students

with a cascade mechanism. That's why we say that "we seed science and harvest future".

The project started in 2018 in Ghana and has grown in Uganda, Kenya, and Tanzania, thanks to a dynamic team of volunteers, local partners, and international funders (Italian Ministry of Foreign Affairs and International Cooperation, University of Rome Tor Vergata, Waldensian Church of Italy, National Geographic Society).

After the covid-19 breakout, we had to interrupt all in-person activities but still decided to keep the project active on a WhatsApp community. Despite the difficulties related to internet access and devices availability (most of the teachers can use a smartphone but notebooks are rare), the community was active and reactive. Based on such a good response we planned a long-term new mode facing the challenge as an opportunity: SeedScience digital conversion. The new project has started in June and will run until September 2021. 25 teachers from four different countries are attending a self-pace training on the Omprakash platform. Trained teachers from the former in-person training are now online mentors and provide feedback and support to new trainees. The community meets periodically online and is impressively growing thanks to interaction and collaboration!

5. Acknowledgements

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Perception of Recycling and Environmental Pollution in Preschool Children

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Abstract. It was aimed to investigate environmental pollution and recycling perception of preschool children. The drawing technique was used so that children could express the concepts of environmental pollution and recycling. This research was carried out with the participation of 110 preschool children aged 5-6 years in Afyonkarahisar In this study, which is based on qualitative research techniques, interview and drawing techniques were used. Data were collected by working with children in different schools for 4 months. It was observed that children aged 5-6 have similar ideas about environmental pollution and recycling. Especially in the preschool period, environmental education starts in the family.

Keywords. Environmental Pollution Pre-school, Recycling.

1. Introduction

Pre-school education is development and education process that covers years from the day the child is born to the day he starts primary school and has an important place in later lives of children, in which physical, psychomotor, social-emotional, mental and language developments are completed to a large extent, and personality is shaped by education provided [1]. In addition to supporting the developmental areas of preschool children, it is very important to increase environmental awareness. During this period, children's interactions with environment increase. For a sustainable environment, it is important to raise children with environmental awareness.

Environmental education is the development of attitudes and skills for the protection of environment and demonstration of environmentally sensitive behaviors. One of the primary aims of environmental education is to raise individuals who are sensitive to environment and environmental problems and be willing to take part in their solution [2]. Environmental awareness will enable them to develop positive attitudes towards the environment.

The concept of environmental education in preschool period was first used by Jaus in 1982 [3]. In most studies, the importance of environmental education in creating positive attitudes towards environment and preschool education in developing positive attitudes towards the environment is expressed [4,5]. It is stated that interest in the environment and association with nature begin at an early age [6]. It has been emphasized that positive attitudes towards environment are shaped by formal education process and especially preschool education is extremely important in this formation [7]. Considering early developmental characteristics of children, environmental education will contribute to children's cognitive development (questioning, discovery, etc.) and will also enable them to develop positive attitudes towards preschool science education. Children can find answers to their questions by exploring nature, which is a rich research environment. As a result, nature can be defined as an open classroom that supports cognitive and physical development of children [8]. Environmental education given in preschool can contribute to children's better understanding of their living environment and to develop positive attitudes towards environment [9]. Although studies on perception of environment in Turkey define the attitudes of students who have reached the age of puberty towards environment as positive [7,10]. Environmental education generally comes to fore in secondary education and higher grades, and its application area is limited in preschool period [11].

Environmental pollution is intense mixing of substances that negatively affect the lives of living things. Unfortunately, it damages the structure of inanimate objects into air, water and soil. Awareness of children about environmental pollution is also a situation that includes environmental education. It was aimed to investigate what comes to mind of children when environmental pollution is mentioned.

Recycling is the conversion of various waste materials (glass, paper, aluminum, plastic, battery, motor oil, accumulator, concrete, organic wastes and electronic wastes, etc.) into secondary raw materials through various physical and/or chemical processes and

reintroducing them into production process [12]. In addition to environmental pollution, how children perceive recycling is within the scope of research. When it comes to recycling, it can be seen that children of this age do not have many schemas that they can visualize in their minds. Because of children's age, the concept of recycling is a somewhat abstract expression. They can express recycling in a very narrow scope, in which cognitive development of preschool children to comprehend abstract operations is not fully developed.

2. Method

This study was designed qualitatively in order to reveal recycling and environmental pollution perceptions of preschool children. Drawing technique was used so that children could express the concepts of environmental pollution and recycling concretely. Children convey their inner world, unconscious wishes and feelings through pictures they draw. Drawing is very important in preschool period as it is a product of children own feelings and thoughts. Drawing reflects children hidden feelings in their inner world, depending on mental-sensory developmental stages. In other words, drawing gives children opportunity to express themselves. Therefore, it is an indispensable tool of children psychology [13].

Since children in this period do not have literacy skills, they can convey their feelings and thoughts through drawings. Children were made to draw and tell what came to mind when recycling and environmental pollution were mentioned.

2.1. Sample of the Study

This research was carried out in Afyonkarahisar province, with the participation of 110 preschool children aged 5-6 years in different schools.

2.2. Data Collection Tools

In this study, which is based on qualitative research techniques, interview and drawing techniques were used. Data were collected by working with children in different schools for 4 months. About 20 minutes were allowed for drawing. They were asked to draw on paper about environmental pollution and recycling. After drawings, interviews were made and notes were taken of what children said. With this study, it has been revealed how children perceive the concepts of environmental pollution and recycling.

Table 1. Categories and Their Contents Created for Evaluation of Information on Environmental Pollution and Recycling with Drawings

Category	Brief description
Full Understanding	• Drawing is enough. • Information is available and correct. • Drawing is suitable for aims.
Partial Understanding	• There is a certain part of desired drawing. • There is missing information. • One of the desired ones is complete and the other is missing, or both are missing (environmental pollution is very good and recycling is insufficient, or environmental pollution and recycling are incomplete) • There is half-fit drawing.
Partial understanding with a specific misconception	• Drawing is correct in one or more aspects. • There are drawings containing misconceptions. • Most of the information is missing
Misconception and not Understanding	• There is insufficient drawing. • Information is incorrect or insufficient. • Drawings are not suitable for learning. • Do not leave blank, unclear answers such as I do not know

In this study, first of all, a short conversation was made about environmental pollution and recycling in order to communicate more easily with children. Then children were asked to draw things that came to their minds about environmental pollution and recycling. After drawing process, each participant was interviewed individually. They talked about painting they had drawn and were asked what

they wanted to convey with painting, and what came to mind when talking about environmental pollution and recycling. Participant's answers were noted. At this stage, researchers tried to reveal how children perceived the concepts of environmental pollution and recycling by asking questions about drawings they made.

2.3. Analysis of Data

For data analysis, firstly interviews were deciphered. Data of study were read repeatedly by researchers and after a general idea was obtained, they began to be analyzed. According to drawings, papers were categorized as full understanding, partial understanding, partial understanding with a specific misconception, misconception and not understanding. Answers given by children to questions were examined one by one. Data was tabulated. Tables were interpreted considering classroom climates of children and characteristics of children.

3. Findings

Data obtained as a result of analysis of drawings of 48-66 month-old children in preschool education about environmental pollution and recycling were interpreted. Categories created to evaluate information on environmental pollution and recycling with drawings and their contents were explained in detail.

Table 2. The Number of Participants in Categories

Categories	Numbers
Full Understanding	15
Partial Understanding	13
Partial understanding with a specific misconception	47
Misconception and not Understanding	35
Total	110

3.1. Full Understanding

Information requested from children in full understanding group, was obtained exactly and correctly. Drawings were made in accordance with the acquisition. There are illustrations including all aspects of a valid answer. For environmental pollution, people polluting environment, people dumping garbage in sea, garbage on ground were drawn. For recycling, recycling bins were drawn, some children divided the recycling bins into different groups. For example, recycling signs were drawn on paper, metal, glass, oil and cans (Fig. 1).

Figure 1. Full Understanding Environmental Pollution and Recycling

3.2. Partial Understanding

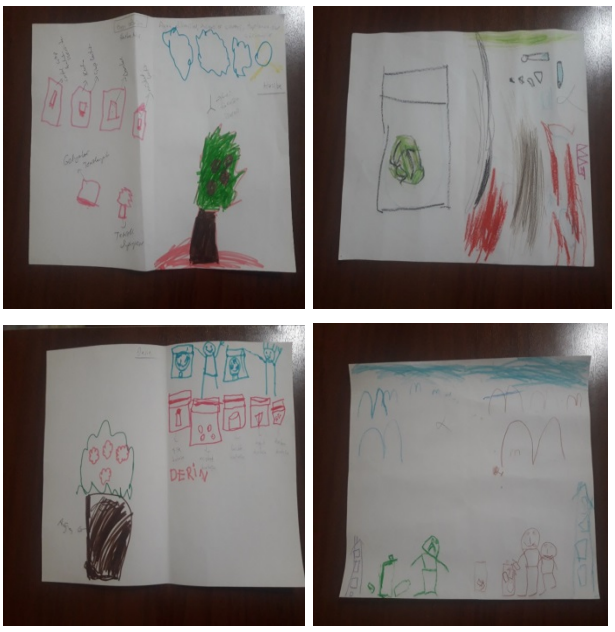

Figure 2. Partial Understanding Environmental Pollution and Recycling

In partial understanding, it was seen that one of desired ones was complete and the other was missing, or both were missing (environmental pollution was very good but

recycling was insufficient or environmental pollution and recycling were incomplete). This is due to incomplete information. There were those who confused environmental pollution with clean environment. There were those who only drew boxes for recycling, but could not fully express what this box was for. Recycle bins for balls, cups, etc. There were those who grouped them in boxes (Fig. 2).

3.3. Partial understanding with a specific misconception

In this section, the drawings were correct in one or more aspects, and meaningless in some aspects. There were illustrations that contained misconceptions. Most of the information was missing. They explained the reasons for some information with illogical reasons. Most of the drawings were in the form of scribbles. Simple answers such as 'garbage' were given to the question 'What comes to mind when you think of environmental pollution?'. There were those who drew trash cans in recycling. Answers such as 'we throw the garbage in the recycling' were in the majority (Fig. 3).

Figure 3. Partial understanding with a specific misconception Environmental Pollution and Recycling

3.4. Misconception and not Understanding

Drawings in this section were insufficient. Irrelevant drawings were made, except for what was requested. Information about environmental pollution and recycling was completely wrong or insufficient. Unambiguous answers were given as "Don't leave it blank, I don't know, I don't understand, I can't draw" (Fig. 4).

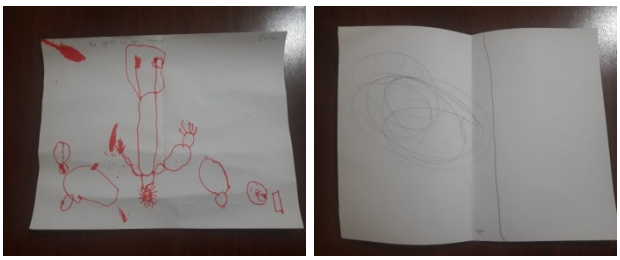

Figure 4. Misconception and not Understanding Environmental Pollution and Recycling

According to the common rubric created in our research named Environmental Pollution and Recycling Perceptions of Children, raters 1 and 2 scored independently of each other. The numbers were given in the table. Comparisons the numbers of consensus and disagreement the reliability of study was calculated by using Miles and Huberman formula (Reliability = consensus /consensus+disagreement). As a result of the calculation, the reliability of the research was calculated as 86%. Reliability calculations over 70% are considered reliable for research [14].

Table 3. Calculation Of Reliability According To The Miles Huberman Formula

Category	Rater 1	Rater 2	Consensus	Disagreement
Full Understanding	11	14	11	3
Partial Understanding	18	10	10	8
Partial understanding with a specific misconception	45	49	45	4
Misconception and not Understanding	11	14	36	1

4. Conclusion and Discussion

According to studies conducted in Turkey and abroad, it is stated that there are many variables affecting children's perception of environment. Some independent variables such as age, gender, socio-economic level, educational status of the family, place of residence and formal education process can affect children's learning, perceptions, attitudes and behaviors. The effects of these independent variables were examined in most studies. It was found that the formal education process helps individuals develop positive attitudes towards the environment [7,4,5]. Similarly, the perception of the environment of

children living in different settlements also changes [15,16,17]. Many studies show that the age factor is also effective on individuals' perceptions of phenomena [18]. Likewise, this information shows parallelism for environmental pollution and recycling. Since preschool children are dependent on foreign sources in terms of knowledge and they have little chance of research, they gave answers in line with the information given to them at school. Quality drawings could not be obtained in the classrooms where the necessary care was not shown on this subject. As a result, similar findings were found in other studies on the subject. It has been observed that children aged 5-6 have similar ideas about environmental pollution and recycling, but the information is not fully formed. Especially in the preschool period, environmental education starts in the family. Preschool education institutions continue to shape environmental awareness together with families. Families and educational institutions have important duties in introducing children to the environment, making them love it, and raising awareness and sensitivity to protect the environment [19]. The same is true for raising awareness of recycling. As parents and teachers, we should pay attention to make the necessary effort to raise individuals who are more environmentally friendly and have a higher awareness of recycling.

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Miller Polyhedron as a STEAM Project

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Abstract. The school must be a place where work is enhanced to create learning opportunities for all students, from the weakest to the brightest, according to the unique characteristics of each one. It is often necessary to change how you teach and how you learn, for example, through challenging projects, such as this one with Miller polyhedron or STEAM activities. Many people consider mathematics to be a difficult and rather abstract subject, but this project has tried to counter this opinion by giving it a usefulness and applicability in the case of geometry, in particular. Thus, a new motivating and meaningful context was created, in which different students participated, experiencing different orientations, from different people, inside and outside the school, as it happened with teachers from the class and with teachers from another project, Mathina. There were many feelings of success, especially in the different working groups, whose conclusions were later shared in the large group and recorded on video. The construction and subsequent manipulation proved to be truly hands-on, with a great deal of accomplishment and dedication, even for future applications of this project, for example, in demonstrations for students of different grades, in peer mentoring.

Keywords. Miller polyhedron, Platonic Solids, Rhombicuboctahedron, Uniform Polyhedrons, STEAM.

1. Introduction

Mathematics is of great importance in our daily lives. Being a universal language, it is understood by many, although it has to be well explained and applied. One of the subjects in which students experience difficulties in mathematics is the study of polyhedrons, which is transversal to several years and domains. This use of geometric solids as an interdisciplinary project, combining math, art, architecture, and chemistry, can be a way to learn more in a better and fun way. The connection between history and science is very strong and can be a very relevant topic for a development work, for example, to build the Platonic solids and other types of solids, in three-dimensional models, checking their properties like the case of regular or uniform polyhedrons, in particular the Miller polyhedron as an exceptional case.

Let us find out why...

2. Platonic, convex and uniform solids

First, we must figure out what Platonic solids and uniform polyhedrons are.

A platonic solid is a polyhedron as regular as possible. Therefore, it is a convex polyhedron (a polyhedron in which for each pair of points, there is a segment contained in the polyhedron that joins them) whose faces are all equal regular polygons, and each vertex corresponds to the same number of faces.

A platonic solid satisfies the following properties: dihedral angles are equal and solid angles at each vertex are equal as well.

To define a uniform polyhedron, it is not enough to say that they respect the following characteristics: polyhedron whose faces are all regular polygons, but not all with the same number of sides, and for which the solid angles at each vertex are of the same type.

If this was the correct definition, the Miller Polyhedron could look like a uniform polyhedron since it meets the described requirements, however, it is not since it disregards the complete definition of a uniform polyhedron. In uniform polyhedrons, faces are all regular polygons that can have different number of sides and for every pair of vertices, there is at least one symmetry of the polyhedron that leads from one vertex to the other.

3. Is the Miller polyhedron uniform?

Second, is the Miller polyhedron uniform?

The rhombicuboctahedron is a uniform polyhedron because: all faces are regular polygons but not with the same number of sides; for each pair of vertices there is at least one symmetry of the polyhedron that takes one

vertex onto the other. In the Miller polyhedron's case that second condition cannot be verified. Since, if we consider a specific pair of vertices, A and B (Fig. 1), any isometry that takes A into B will remove the existing ring of squares from the polyhedron, which changes its final appearance.

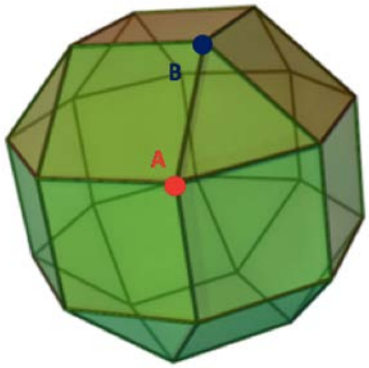

Figure 1. Miller polyhedron

This proves that the Miller polyhedron is not uniform. Even though the pseudo-rhombicuboctahedron is not uniform, this solid is convex just like the rhombicuboctahedron. None of these polyhedrons are platonic since they have faces with different number of sides (18 squares, with 4 sides each, and 8 triangles, with 3 sides each).

Table 1. Types of polyhedrons: a) Rhombicuboctahedron; b) Miller polyhedron

Solids	Convex	Uniform	Platonic
a	X	X	
b	X		

4. Rhombicuboctahedron versus Miller polyhedron

There is a strict relationship between the Miller polyhedron and the rhombicuboctahedron.

If we divide the second polyhedron into three parts as shown in Figure 2, we notice that the Miller polyhedron, results from twisting one of the square cupolas of the rhombicuboctahedron by an angle of 25 degrees. This means that the Miller polyhedron can also be called the pseudo-rhombicuboctahedron. Therefore, both pseudo-rhombicuboctahedron and the rhombicuboctahedron have the same number of faces, edges, and vertices.

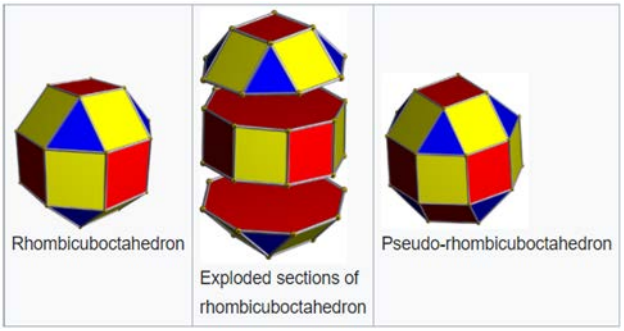

Figure 2. Division of the rhombicuboctahedron

Table 2. Polyhedron's features: a) Rhombicuboctahedron; b) Miller polyhedron

Solids	Faces	Edges	Vertices
a	26	48	24
b	26	48	24

5. Miller polyhedron's importance

Since Miller polyhedron is so different and special, it should be taught to students in secondary school. This is because understanding the differences and oddities of the Miller polyhedron allows them to better understand taught concepts such as what is a uniform polyhedron or what is a Platonic polyhedron, among others.

6. Miller polyhedron's applications

Third, its specifics can be applied in areas other than mathematics such as chemistry, the arts, and architecture.

6.1. In chemistry

The polyvanadate ion $[V_{18}O_{42}]^{12-}$ has a pseudo-rhombicuboctahedron structure, where each square face acts as the base of a VO_5 pyramid.

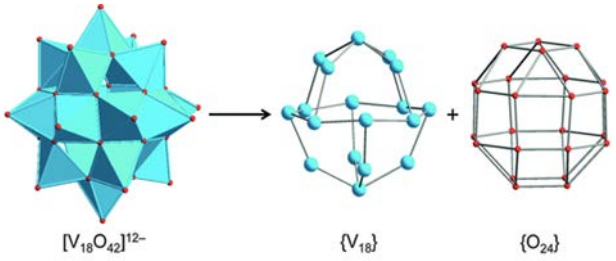

Figure 3. Polyvanadate ion

6.2. In arts

Although Miller's solid isn't used in artworks due to its specifics, the rhombicuboctahedron is used in some. In Luca Pacioli's portrait, of 1495, it's possible to see a rhombicuboctahedron half-filled with water. This solid might have been painted by Leonardo da Vinci, even though the painting is attributed to Jacopo de' Barbari.

Figure 4. Portrait of Luca Pacioli (c. 1495)

The "Moravian star" is a German Christmas' decoration, invented in the XIX century. This star has a rhombicuboctahedron in its internal structure formed by the bases of the pyramids of the object.

Figure 5. Moravian star

6.3. In architecture

Rhombicuboctahedron is visibly noticed in the national library of Belarus. This building was the winner of an architecture competition of the Soviet Union.

Figure 6. National library of Belarus

7. Steps of the research

This project was based on a large research divided into 4 important steps.

7.1. Partnerships

We were proposed to analyze a prototype of the "polyhedron fair" that concerned the Mathina project of the Atractor organization. Atractor is a portal dedicated to the dissemination of Mathematics. In it we can find mathematical content, with images, several interactive materials, and animations.

Atractor is a member of the European Mathina Project, funded by the European Commission's Erasmus+ program. With an expected duration of two years, the project's primary goal is to create extracurricular material aimed at formal and non-formal mathematics education in the areas of spatial visualization, logic, cryptography, symmetry, and polyhedrons.

7.2. Online lesson

Next, we had an online session with Professor Arala Chaves in which he proposed we build a three-dimensional model of the Miller polyhedron and a mold of its vertices, and explore this polyhedron being able to discover its special features.

7.3. Explorations

After reaching some conclusions, we explored again the resources of the Mathina project - polyhedron fair - already in its final version, discovering the various types of polyhedrons, whether uniform, regular or platonic and their characteristics.

7.4. Final achievements

In the end, with the help of Professor Arala Chaves and his instructions, we further analyzed Miller polyhedron and its specifications, reaching unimaginable and previously unknown conclusions (previously explained).

8. Conclusion

In conclusion, the manipulation of the three-dimensionally constructed solids proved fruitful, since in addition to the obvious properties we had previously studied, it gave us the opportunity to discover new, previously unknown characteristics about these solids. The solid that initially stood out was the rhombicuboctahedron for its uniformity and its applications, however, in the end Miller polyhedron, introduced us to a new world of mathematics, with unique and mind-blowing peculiarities. Its study allowed us to better understand the properties of the simplest polyhedrons and why the Miller polyhedron is a special case, making us real scientists by consolidating mathematical knowledge and its usefulness in our daily lives.

9. Acknowledgements

We want to thank Professor Arala Chaves for all his teachings and clarifications about the Mathina and Atractor projects. We would also like to thank teacher Maria Manuela Simões for all her help and support in this project and teacher Nuno Francisco for reviewing the structure of the article.

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Transferable Methodologies between In-Class and Online Learning - A Three-Steps Learning Process

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Abstract. This paper presents the results of the project for the study of physics, based on integrated methodology, which includes physical models done by students, with transpose into digital models and analyzing them using the Tracker application, to deduce the laws that explain their function. The methodology was developed so it can be used for physics both in in-person classes, as online, or even for hybrid learning. Originally designed as a way to change students' perceptions for the study of physics and STEAM (Science, Technology, Engineering, Arts and Mathematics), they have identified values that recommend it, in our opinion, for the current situation due to the Covid-19 Pandemic. which led to repeated and rapid changes in the organization of the education system.

Keywords. Hybrid Learning, Interactive Simulation, Transferability, Video Analysis.

1. Introduction

The transition from classroom learning to online learning due to the constraints of the Coronaviruv-19 pandemic has been abrupt, in most cases Both teachers and students have not been prepared for an appropriate approach, both emotionally and digital skills. The most affected by this lack of experience in online education were the STEM components (Science, Technology, Engineering, Art, and Mathematics) whose classroom study involves laboratory experiments.

For the study of physics, most teachers have used the so-called interactive simulations, which allow an investigation of basic physical phenomena and the deduction of their laws.

The method is not a bad one, but it has some limitations, in terms of the involvement of students in their educational process, as well as the skills that students can acquire in this way. A short survey of our high school students found that most students found that the interactive applications presented by the teacher during online courses were not illustrative, far from the reality they know, boring and irrelevant. Moreover, the students stated that they are not interested in accessing again the virtual experiments presented by the teacher, in order to use them to understand the studied phenomena.

To deal with this situation, we looked for a new method that could be used instead of the traditional laboratory, which would exploit the interests and knowledge of students and contribute to the development of their transdisciplinary skills. Due to the main steps, we propose, we called the method "three-step method" or Augmented Learning (AL).

The methodology developed was based on a heuristic tool, known as Gowin's Vee, developed precisely to help students clarify the nature and purpose of laboratory studies in science. For instructors, the design phase of education based on this tool can be a way to realize the importance of a new type of proficiency transfer to students, deeply participatory. At the same time, we aimed to integrate STEAM components, so that students can develop transferable skills, especially digital skills.

The proposed steps are designed to help students understand the structure of the scientific analysis of a phenomenon, starting from identifying the main question to be answered, the key concepts involved in the analysis, the methods used to answer questions of interest, gaining knowledge.

The first step is to introduce the phenomena to be studied, through a trigger question or a video, which are related to their previous knowledge, even some that may be seemingly far from reality, such as cartoon movies. This step is also a challenge for students, who are required to make a practical model, which allows the study of complex physical phenomena.

In the second stage, the students were asked, after a basic preparation for using Algodoo, a 2D physics-based sandbox

freeware, to create an interactive digital simulation, based on phenomena identified in the trigger used previously. Thus, students could recreate reality, developing skills for analysis, design and evaluation of a digital product that can supplement the study of physical phenomena in the laboratory.

The third step is to analyze their simulation, using the video analysis software Trackers compared to the video recording of the operation of the model made in the first step. As an extension, the students were asked to identify practical situations in which the basic principles of the studied phenomena and of the reproduced mechanisms are found, to record them in operation and to perform their video analysis.

By comparing the results obtained by video analysis of the digital simulation and the mechanism created, due to the very good agreement between them, students can deepen their understanding of the phenomena that formed the basis of their construction and operation.

Based on these steps, students completed Gowin's V diagram, which will allow teachers to assess their understanding of the phenomena.

This process of knowledge for students replaces the process considered boring, of listening to teachers' lectures, even if they include live demonstrations or digital simulations. Students' skills are developed transdisciplinary. The methodology can be applied to the study of individual or complex phenomena, the replacement of Algodoo with specific applications to other STEM domains allowing the transferability of the described steps to these domains.

In our opinion, the methodology we have developed can be used in both traditional and online education, thus allowing a two-way transition between the two types of education.

The developed methodology has the advantage that it addresses the different learning styles of students. At the same time, it can be integrated into a hybrid education, when students can be assigned different tasks, depending on the location in which they participate and the equipment they have at their disposal and whose results can be compared, with a very good agreement between them.

The purpose of this methodology is to motivate students to approach the STEAM fields, to understand their role and to become a viable and assumed option for their future educational path**.**

2. Contextualization

In the ambit of an Erasmus+ Project (Science Connection), students from the 9th to 11th grade, wich were participants in the blended mobility, developed a learning scenario to study the cinematics and some basics dinamics laws, using Tracker as a computer-based learning tool. Their work was presented in a peer-to-peer system, in the first blended mobility for school learners that took place in Granada, Spain, and was applied to regular classes from our school.

3. Motivation

Based on our previous experience as teachers and the work developed within the Science Connect project, we have identified the main reasons for a new approach to physics study.

- The challenges of the CORONAVIRUS Pandemic - 19 have led to new approaches to education. Restrictions caused by the CORONAVIRUS Pandemic have determined the need to quickly find solutions to educational alternatives.
- The alternation between online, hybrid, and in-person classes.
- The need to find methods for the study of STEAM, applicable to any of these forms. The challenges of teaching STEAM, especially physics, require tools and techniques that are not found in other disciplines.
- The need to develop alternatives for STEAM virtual labs. Existing virtual labs are mostly boring for students, who do not perceive them in connection with reality.
- The desire to increase the attractiveness of the STEAM study. The use of previous experience and knowledge, as well as digitization, increase the chances of students accepting the STEAM study, otherwise difficult to accept.

Both teachers and students were considered in the design stage of the activities, each from their own perspectives.

For teachers, our goals were to development of active methodologies that effectively involve students in their learning; to identifying tools that allow connections between previous experience and different STEAM topics; to create an implicit demonstration of the contribution that STEAM can have in everyday life; to help them for offeringnew approaches to students with learning difficulties; to increase the aaptability for different learning styles.

Students are the main core of the project. For them, we propose to identify the means to build one's own knowledge Development of own learning processes, useful in the perspective of LLL, transition from a passive student to an active one and responsible for his own education and changing the role of the student, in the main actor of the educational process were our intention. Building skills and competencies based on curiosity and creativity was the natural result of the whole project participation, as well as for students who attended the courses based on the same methodology.

4. Theoretical consideration

Interactive simulations, many of them schematic, of relatively simple scientific phenomena or simple devices do not meet the training requirements of students' skills. They do not facilitate creativity-based investigation. These simulations are not adaptable for different learning styles. Using them it does not help students with learning difficulties to understand the studied phenomena. Many of these simulations does not study more complex phenomena in their interaction. But most importnant, they have relatively few values that they can manipulate.

5. Methodology

The methodology includes the integration of practical execution of simple devices or reproduction of phenomena, their video recording in motion, and the analysis of the video recordings of their use, based on Tracker software.

We named these steps Practical, Digital, and Video Analyze.

5.1. Practical activities

Students are asked to build a device / mechanism, giving them a video trigger or an image. The model works based on the phenomenon / phenomena that we want students to study. The first device that we used was the catapult, which allowed to mae a comple study, both from cinematic and dynamic point of view, as in Fig. 1.

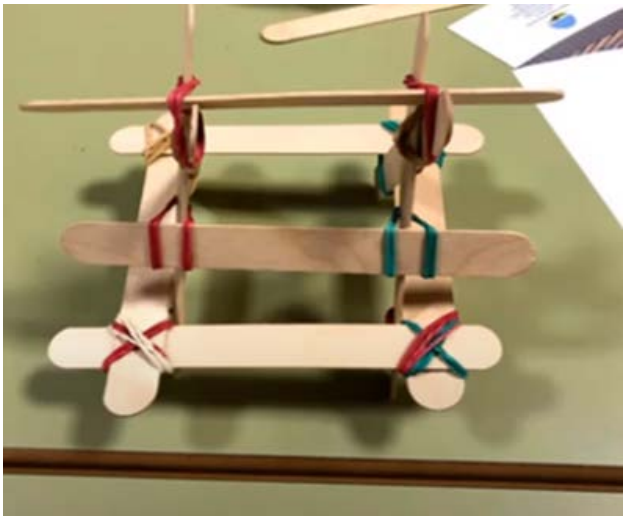

Figure 1. A finished model of catapult done by students during the activity

A short specification for the activities for applying the methodology:

- Students are asked to build devices that can be built individually or as a team, using common materials, as in Fig.2.
- Images or video tutorials can be used for suggestions.
- Students are informed that in the evaluation of the activity, creativity and imagination will be appreciated, to the detriment of the ad-literam reproduction of the presented model.

We identified some suggestions for these types of activities. For the potential emotional impact they have, historical images / videos can be used, possibly Leonardo da Vinci's sketches. The method can be applied to other simple, or more complex, mechanisms of a practical-applicative nature. The same method can be applied to other STEAM domains

Figure 2. Students making their model of catapult, working as a team

5.2. Digital activity

Was done using Algodoo, a free software special designedfor helping teachers and students in digital modeling of physical devices that can be used and studiied interactively. A version of the catapult, which can be used interactively, is in the Fig. 3.

The ICT teacher or the physics teacher must present the students with Algodoo tools, prior to the creation of the digital model, or provide them with tutorials.

There are multiple solutions for creating the digital version for the practical layout. Algodoo application can be used mainly for online or hybrid classes. For face-to-face classes, it can only be used if there are laptops in the lab.

Students are informed that in the evaluation of the activity, creativity and imagination will be appreciated, to the detriment of the ad-literam reproduction of the presented model.

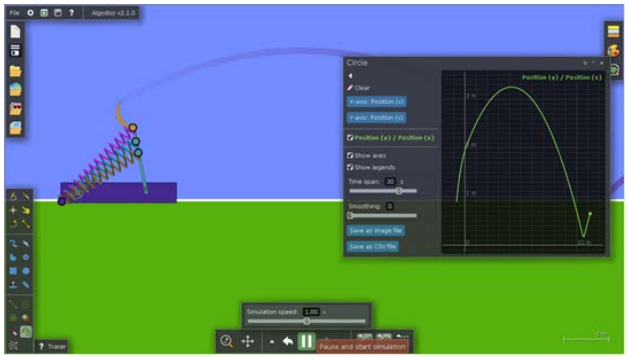

Figure 3. A digital catapult, done by students, showing the trace of the projectile and the graph

Students will be asked to modify different parameters of the simulation, as well as to record the different data sets provided by the application.

For graph-motion correlation, it is recommended to record the trace of motion, simultaneously with the graph display in xOy spatial coordinates.

5.3. Video analysis

Students recorded both the physica and the digital model. They used their own devices for recording. The videos were uploaded on Tracker, and using the specific techniques were analised.

We will not present in detail the use of Tracker, as well as the use of Algodoo, for the creation of the digital model and the video analysis, which will be realized in a next stage of our Science Connect project.

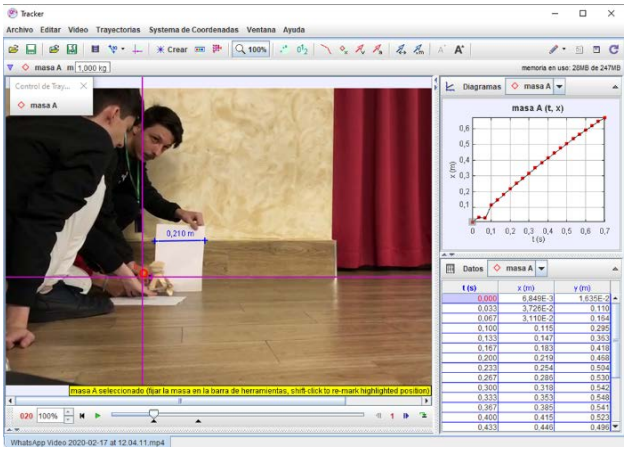

Figure 4. A screenshot of one video analyze done by students, with the graph and data table

6. Conclusions

Based on these steps, students completed the Gowin's V diagram, which will allow teachers to evaluate their understanding of the phenomena.

This process of knowledge for students replaces the boring process of listening to teachers' lectures, even if they include live demonstrations or digital simulations. Students' skills are developed transdisciplinary. The methodology can be applied to the study of individual or complex phenomena, the replacement of Algodoo with specific applications to other STEM domains allowing the transferability of the described steps to these domains.

In our opinion, the methodology we propose can be used both in traditional and online education, thus allowing a two-way transition between the two types of education.

Both the physical or digital creation stage of the model and the video analysis can be used individually, either only in the classroom or online, under the teacher's coordination, also presenting the possibility of using hybrids, which would allow students more involvement. good and with development of transdisciplinary skills.

7. Acknowledgements

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A Year of the COVID-19 Lockdown: Comparative Analysis of Distance Learning Approaches in TNMU

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Abstract. The purpose and history of introduction of distance learning components in educational process at the I. Horbachevsky National Medical University in Ternopil (TNMU) is shown. The key elements of implementation of full-scale distance education workflow at TNMU during the COVID-19 lockdown as well as its changes are presented. The distance education features of teaching of Medical Informatics and Biostatistics course at TNMU are noted. The experience gained during the implementation of full-scale distance education at TNMU within the COVID-19 lockdown is presented. The analysis of students' performance during the full distance educational period in comparison with a blended part of the Medical Informatics and Biostatistics course are presented. A value of real-time online communication as component of distance education process is signed.

Keywords. Distance Education, Comparative Analysis, Learning Management Systems, Moodle, Google Suite for Education, Office 365, Medical Education.

1. Introduction

Conceptual approaches to introduce modern information technologies in the field of medical education have included the application of Learning Management information Systems (LMS) which also often provide services of distance education too - as well as learning material management systems (LMMS or LCMS - learning content management systems) [1-2].

Global pandemics (like COVID-19) has introduced new challenges and demands for organization and providing of the educational process. Higher education institutions should be ready and capable to continuation of the fully online and remote educational model for a long time [2].

2. Organization of distance education process at TNMU during the COVID-19 lockdown

Distance Education (DE) technologies were introduced at Ternopil National Medical University (TNMU) in 2006 when LMS Moodle [3] was used to evaluate the results of students' self-preparation for practical classes. The use of the Moodle LMS was continuously expanded during the following years [2, 4-9].

Important changes took place in 2012. The Microsoft Office 365 [10] and Google Suite for Education [11] services were introduced almost simultaneously at TNMU. Up to now Google Suite platform provides corporate e-mail service for TNMU and being used as a centralized user authentication tool for all TNMU information services.

Since March 12, 2020, when the COVID-19 lockdown in Ukraine was introduced, TNMU has been using all available distance learning services on a full scale [2]. Students have been able to:

- use training materials posted on the LMS Moodle platform web-site [12] for training;
- post their works in electronic form through Moodle activities like "workshop", "assignment", etc. ;
- communicate with teachers through Google services (texting via Gmail / Chat, and having video-conversations via Hangouts / Meet / MS Teams).
- watch educational videos and video-lectures on teachers' YouTube channels (for example [13]).

At the end of spring semester of 2020 LMS Moodle has been used to perform a final control as well. Exams were conducted in form of test assessment. Unlike previous times, more different types of questions and forms of quizzes were used. For example, an "essay" Moodle question type was used to accept students' answers instead of "oral" part of exams.

Further DE adjustments and modifications were arranged in TNMU for 2020-2021 academic years as COVID pandemic lasted

and national lockdown in Ukraine had extended once again. Major changes were focused on maximization of the online communications in real-time between teachers and students:

- each scheduled class were provided in form of online MS Teams meeting;
- same approach were used for implementing an "oral" part of exams.

The problem is to perform comparative analysis and provide assessment of effectiveness of different approaches to providing distance learning in medical education based on data, collected by authors during a year under COVID-19 lockdown.

The aim of paper is to present results of comparative analysis of different approaches to implementation of distance learning technologies into medical education were used in TNMU during COVID-19 pandemic lockdown.

3. Teaching the Medical Informatics and Biostatistics course at TNMU before and during COVID-19 lockdown

The Medical Informatics and Biostatistics (MIB) course at TNMU is offered to 2nd year students at the medical school and now including 14 hours of lectures, 32 hours of practical classes and about 60 hours assigned to self-guided work. Course was re-designed to use "blended" education methodology since LMS Moodle inception at TNMU [14]. Students were obligated to perform some amount of online activities in addition to classroom studies. As a rule, a topic of the MIB course in LMS Moodle includes the following elements (Fig. 1):

1. Required practical classes materials and methodical instructions.
2. List of tasks that must be completed (during class hours or individually).
3. Recommended additional educational materials.
4. Assessment tools. Using "assignment" activity students have to submit results of their practical works. A "quiz" activity has been used to perform assessment of theoretical knowledge.

Such extensive background allowed an easy transition from the "blended" mode to a full scale distance education workflow when the lockdown was introduced in Ukraine on March 12, 2020. Main changes provided in the course to support a full-scale online educational process were aimed on extending its accessibility to students and were presented in previous work [2].

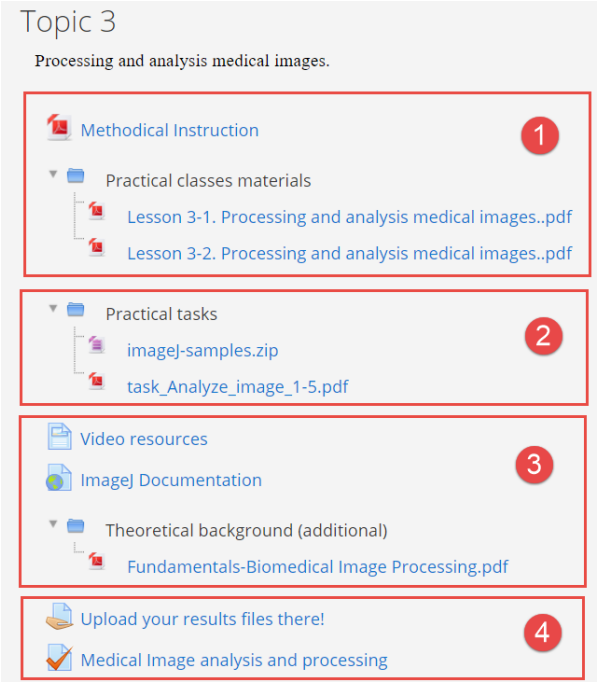

Figure 1. Structure of a topic of the MIB course in LMS Moodle

4. Students' performance of MIB course studding during COVID-19 lockdown

The analysis of results of teaching the Medical Informatics and Biostatistics course to foreign students by the 1st author is used to present practical outcomes of migrating from the blended education model to full scale DE workflow and its further adjustment upon lockdown was extended.

It should be noted that TNMU uses a common Ukrainian academic grading system with 12 levels of students' achievements, where "4" is a minimal positive grade. According to TNMU's rules each student must obtain grades for each practical class. Course average has been calculated as a final grade. During the 2019/20 academic year 184 students in 14 groups were taught. The average scores achieved by students during the blended part (topics 1 to 10) of the MIB course is shown on Fig.2. The next figure (Fig. 3) presents the average scores for the full scale DE part of MIB

course during March / May of 2020 (6 topics). Finally, the total MIB course average scores are shown on pair of charts – as of the end of semester (Fig. 4) and after all committed "reworks" and "adjustments" (Fig. 5).

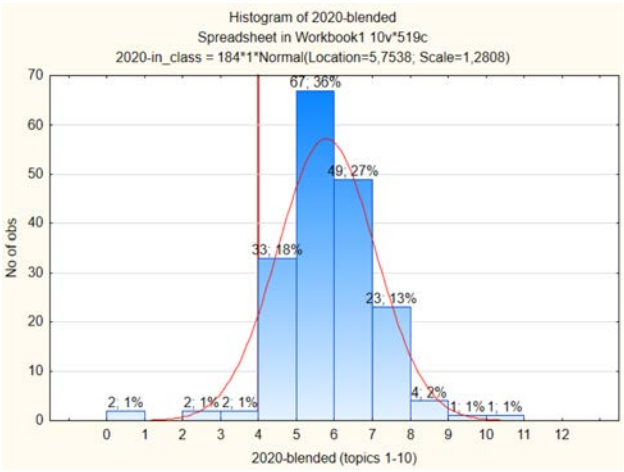

Figure 2. Students' average score for the blended part of the MIB 2019/20 course (topics 1-10)

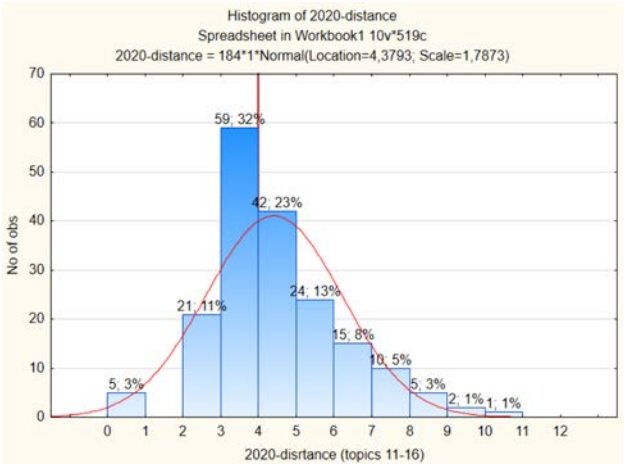

Figure 3. Students' average score for the DE part of the MIB 2019/20 course (topics 11-16)

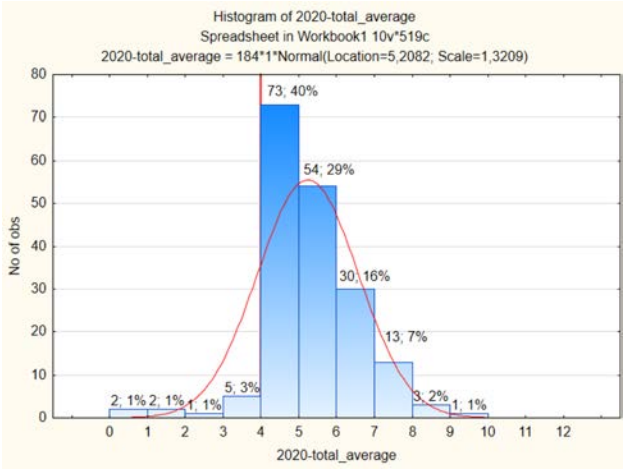

Figure 4. Students' total average score for the total MIB 2019/20 course

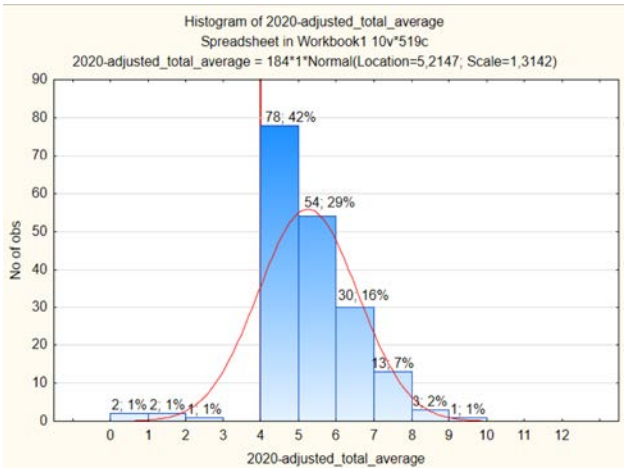

Figure 5. Students' total average score for the total MIB 2019/20 course (adjusted)

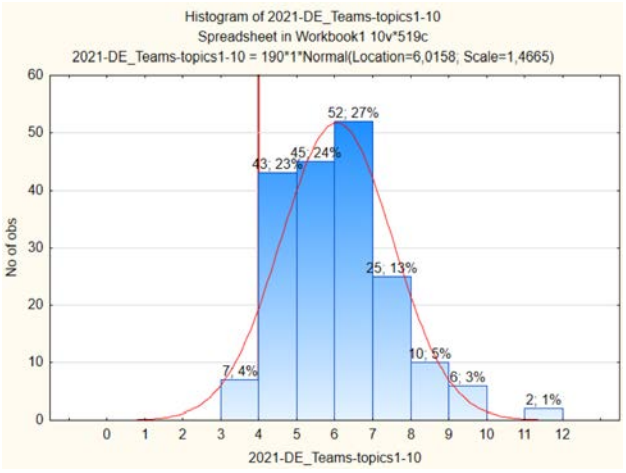

Figure 6. Students' average score for the blended part of the MIB 2020/21 course (topics 1-10)

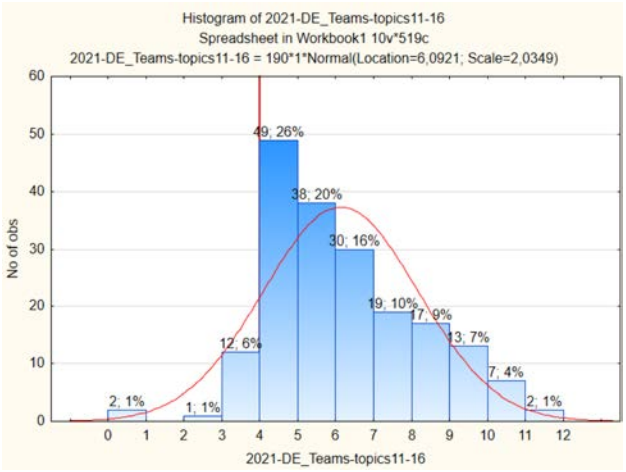

Figure 7. Students' average score for the DE part of the MIB 2020/21 course (topics 11-16)

During the 2020/21 academic year 190 students in 14 groups were taught respectively. Despite uniform education method has been used (full DE with meetings in MS Teams) – the same data alignment has been applied with aim

of comparing to the previous year's results was possible. So, the average scores achieved by students during learning topics 1 to 10 is shown on Fig. 6 and topics 11 to 16 – on Fig. 7 respectively. Same way, the total MIB course average scores are shown on pair of charts – as of the end of semester (Fig. 8) and after all committed "reworks" and "adjustments" (Fig. 9).

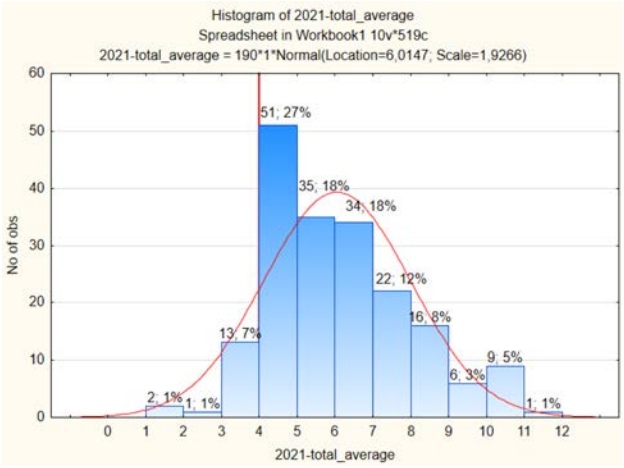

Figure 8. Students' total average score for the total MIB 2020/21 course

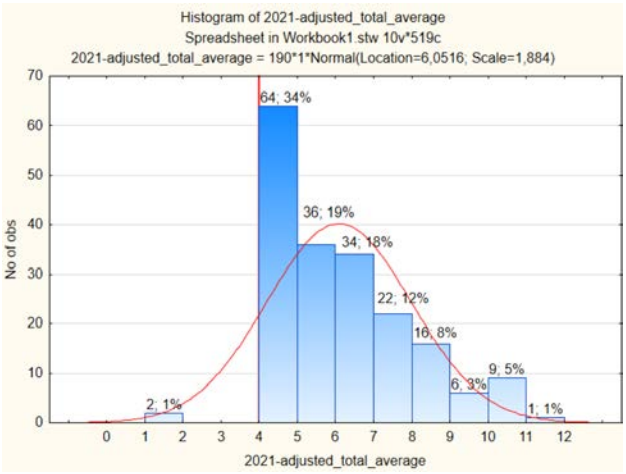

Figure 9. Students' total average score for the total MIB 2020/21 course (adjusted)

The following main outcomes are found after the source data and the corresponded charts (Fig. 2 and Fig. 9) have been studied:

- migration from the blended mode to the full-scale DE workflow in 2019/20 academic year was a very difficult process: grades fell down for all students significantly (Fig. 2 and Fig. 3). About half of students (85 of 184 or 48%) failed to earn even a minimal positive average grade ("4") for topics were taught during DE part of course;
- consequently, general performance of students in the MIB course was quite low in 2019/20 when 42% (78 of 184) of them barely managed to earn credits with grades just above a minimal positive;
- continuation of full-scale DE workflow in 2020/21 academic year is lasted more smoothly. Day-to-day students' performance (Fig. 6, Fig. 7) becomes closer to values were recorded in the past during blended mode (Fig. 2);
- general performance of students in the MIB course improved in 2020/21 as well. Number of those who earned credits with grades just above a minimal positive decreased by 8% (64 of 190 or 34%);
- finally, number of successful students (with average grade above "8") grown significantly form 3% in 2019/20 to 17% in 2020/21

Insufficient basic educational skills and poor educational background of foreign students at TNMU were identified as problems by authors far before COVID-19 lockdown. This is quite obvious because most students come from developing countries with low income and high poverty (Africa, Middle East and South Asia).

Low common digital literacy competencies along with basic computer skills of most of foreign students at TNMU provides additional obstacles which make transition from blended mode of educational process to full DE quite difficult for those students.

Above factors partially explains observed unsuccessful educational outcomes in 2019/20 academic year.

Continuous usage of full-scale DE stimulates students to develop and improve necessary self-education, computer and communication skills to be able to deal with online educational environment. Improved educational outcomes in 2020/21 academic year confirms this.

Introduction of regular online videoconferences as mandatory component of process of distance education also boost educational outcomes significantly for such mostly theoretical disciplines like Medical Informatics and Biostatistics. However, authors have to admit, that it also almost doubled teachers' real workload. So significant concerns appears regarding maintaining of teachers' personal health in long-term prospective.

5. Conclusion

The importance of readiness for full scale distance learning in high medical education is signed. This is illustrated by a history of introduction of the components of distance learning in education process at the I. Horbachevsky National Medical University in Ternopil. The key elements of implementation of full-scale distance education workflow at TNMU during the COVID-19 lockdown as well as its changes are presented. The distance education features of teaching of Medical Informatics and Biostatistics course at TNMU are noted. The experience gained during the implementation of full-scale distance education at TNMU within the COVID-19 lockdown is presented. The analysis of students' performance during the full distance educational period in comparison with a blended part of the Medical Informatics and Biostatistics course are presented. Low performance of foreign students during online learning of the MIB course was noted and explained. A value of real-time online communication as component of distance education process is signed.

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[10] https://www.microsoft.com/en-us/education/products/office

[11] https://edu.google.com/products / gsuite-for-education

[12] https://moodle.tdmu.edu.ua

[13] https://bit.ly/2Mzj7j3

[14] https://moodle.tdmu.edu.ua/course/view.php?id=403

Nanosystems for Environmental Remediation (Optical Sensors)

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Abstract. Pollution is a concern to every human, since biological systems are influenced by it. Water is crucial to every form of life, so we must keep it clean. With that said, our project has the goal to help detect water pollutants in a quantitively way, more specifically, heavy-metal ions. Their detection is going to be performed through optical sensors made from the synthesis of luminescent compounds based on lanthanide ions and metal-organic frameworks (MOFs). Under normal water conditions, they will emit light while in the presence of pollutants, their luminescent properties are changed, thus enabling the monitoring of such pollutants.

Keywords. MOFs, Luminescent Compounds, Lanthanides, Optical Sensors.

1. Introduction

The importance of clean water in our life is not always acknowledged as much as it should be. So, with this project, we hope we can facilitate the detection of water pollutants through the optical sensors described in the abstract. The synthesis of luminescent compounds is made using lanthanide ions and metal-organic frameworks.

1.1. Lanthanide Ions

All lanthanide elements form trivalent cations, Ln^{3+}. They are elements from the 6th period of the periodic table and they have remarkable properties, in particular their peculiar photoluminescence. Lanthanide ions conjugated with organic ligands create the so called “antenna effect”. In this phenomenon, the ligands are able to efficiently absorb energy and transfer it to lanthanides, which in turn emit strong light. These properties have allowed lanthanide ions to be used on lasers, optical fibres and biomarkers [1].

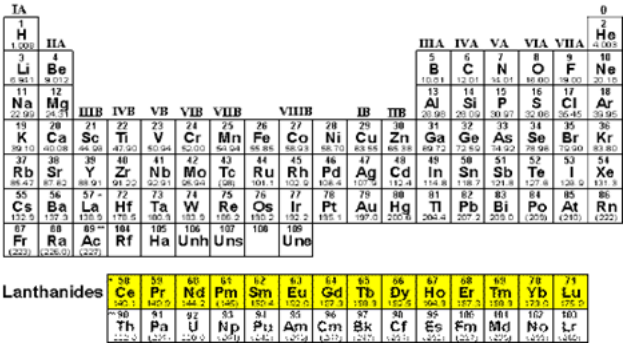

Figure 1. Lanthanides position on the periodic table

1.2. Metal-organic Frameworks (MOFs)

Metal-organic frameworks (MOFs) are porous crystalline materials made of an inorganic metal center and self-assembled polydentate organic ligands. Its versatile structural features, large surface area, high porosity, etc. has captured widespread attention. They are applied on many areas, such as catalysis, energy storage, luminescence, sensing, magnetism, proton transport, etc [2-3].

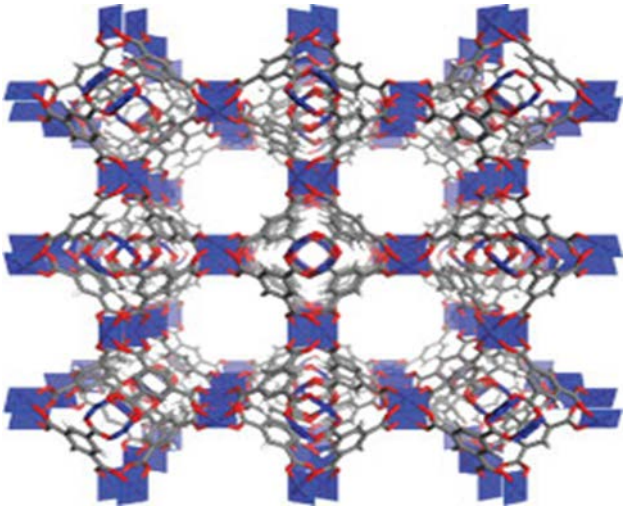

Figure 2. Representation of MOFs – Metal-organic Frameworks

1.3. Ln-MOFs

The materials selected for this project are LnMOFs, which combine the lanthanide’s luminescence with the MOFs’ porosity and robustness, making them highly suitable candidates for the detection of water pollutants as optical sensors [4].

2. Experimental Section

2.1. Material

- Eu $(NO_3)_3 \cdot 5H_2O$
- Tb $(NO_3)_3 \cdot 5H_2O$
- H_2O
- 1,3,5-benzenetricarboxylic acid (H_3BTC)
- *N, N*-dimethylformamide (DMF)

2.2. Synthesis of Eu-MOF and Tb-MOF

Eu-and Tb based MOFs were synthesized following the same procedure by solvothermal method. [2]

Initially, two aqueous solutions were prepared by dissolving 0,7 g of each Ln^{3+} salt in 1,7 mL of H_2O. After that, each one was mixed with another previously prepared solution of H_3BTC, (0,33 g) in 8,33 mL of DMF.

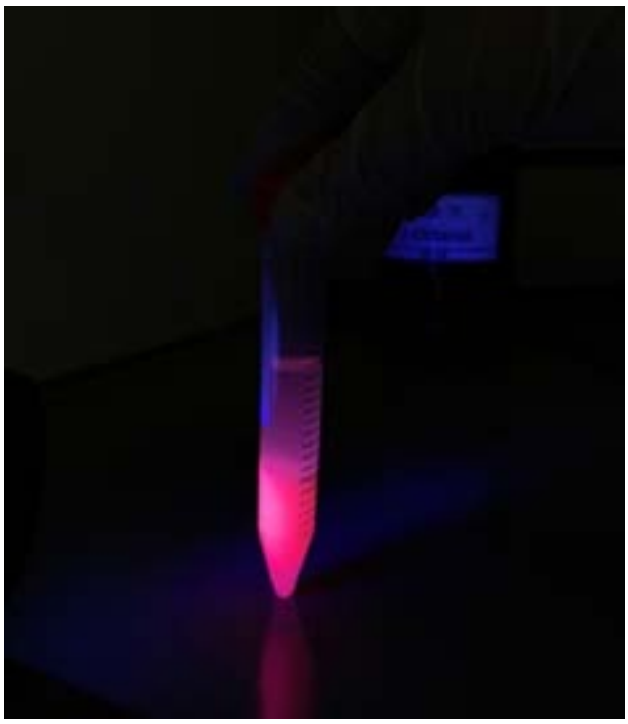

Figure 3. Sample of Eu-MOF under UV light (λ = 366 nm)

Then, a magnetic bar was added to each one of the two resulting solutions in order to be stirred on the magnetic stirrer for about 10 minutes at room temperature, to completely homogenize the resulting mixture.

Afterwards, each mixture was transferred into a Teflon-lined stainless-steel autoclave. They were heated in the oven at 100ºC for 12 hours. After cooling, a solid was observed, which was washed three times with anhydrous methanol. After each wash, the two solids were separated by centrifugation. At the end of this process, they were dried in a Büchi drying pistol at 60ºC and 175 mbar.

At the end of the drying process, our samples were emitting light under UV irradiation (Fig. 3).

2.3. Characterization of Eu-MOF and Tb-MOF

The characterization of the samples was made through three techniques: Fourier-transform Infrared Spectroscopy (FT-IR), scanning electronic microscopy (SEM) and X-ray diffraction (XRD).

3. Results

3.1. Results of Characterization

3.1.1. Fourire-Transform Infrared Spectroscopy (FT-IR)

FT-IR allows the observation of the vibrational bands, which are characteristic of each bond of our compounds, through the absorption of light. The starting organic ligand – H_3BTC (Fig. 4), and the Eu-MOF (Fig. 5) and Tb-MOF (Fig. 6) materials were analyzed in the spectrometer.

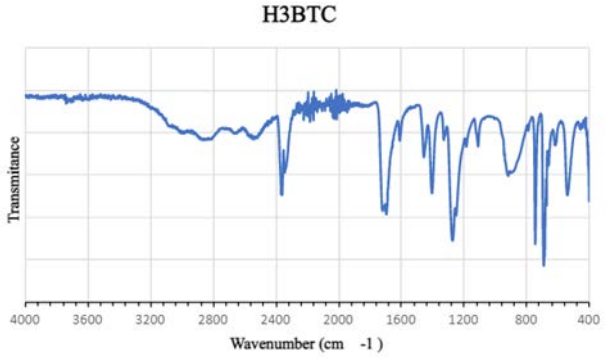

Figure 4. Infrared spectrum of H_3BTC

On the previous figures we can observe that in the 4000-400 cm^{-1} range there are some common peaks in the three spectra. The peak at around 1690 cm^{-1} on the spectra of Eu-MOF and Tb-MOF is attributed to a methyl group from DMF molecule. Also, in these two spectra it is visible two peaks around 1093 cm^{-1} and 764 cm^{-1} that correspond to two vibrations of aromatic rings. The FT-IR profiles of both Ln-MOFs are in good agreement with the reported data strongly suggesting their successful preparation [2].

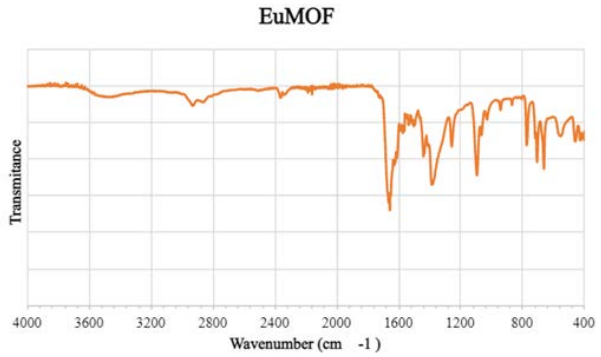

Figure 5. Infrared spectrum of Eu-MOF

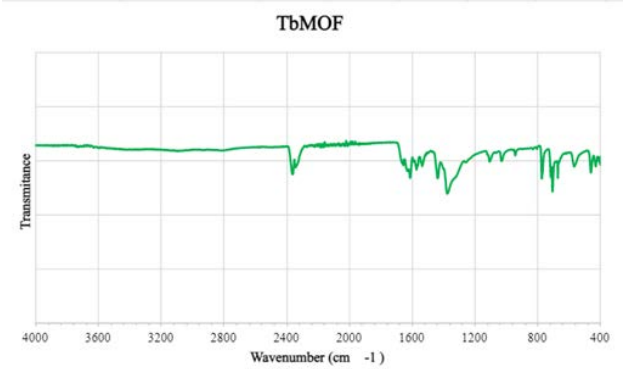

Figure 6. Infrared spectrum of Tb-MOF

3.1.2. Scanning Electron Microscopy

The Eu-MOF and Tb-MOF samples were prepared for electron microscopy analysis: each one was placed into an aluminium support that was covered with double-sided carbon tape, in order to fix just a few grains of our samples. The double-sided carbon tape was used to avoid the accumulation of electrons on the observed surface when it's on the electron microscope. This method is used to observe the morphology and size of molecules.

The SEM images of Eu-MOF and Tb-MOF are displayed in Figures 7 and 8, respectively. The results show that both samples are composed by highly crystalline particles with needle-like morphology. The particles in both materials exhibit an average width of approximately 7.0 um.

3.1.3. X-Ray Diffraction

The XRD is a method that give information about the crystalline structure (3D) of compounds. On Figure 9 are the XRD patterns of Eu-MOF (blue) and Tb-MOF (orange), that are according to literature data. This means that the peaks that we observe are located on the expected 2θ angles and with the expected relative intensity.

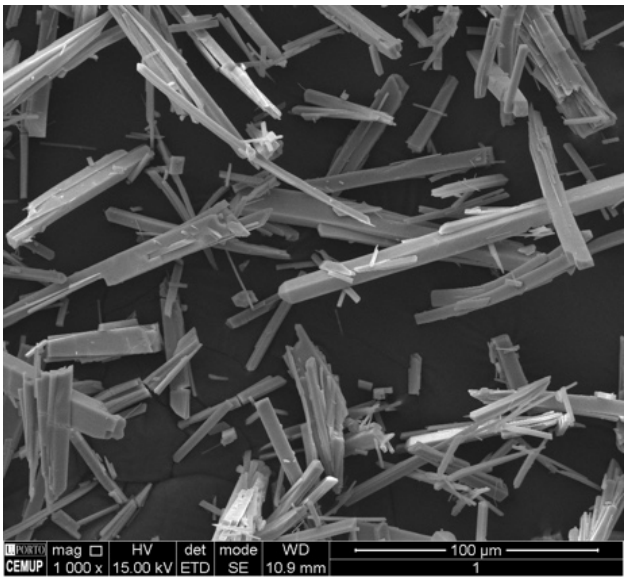

Figure 7. SEM image of Eu-MOF

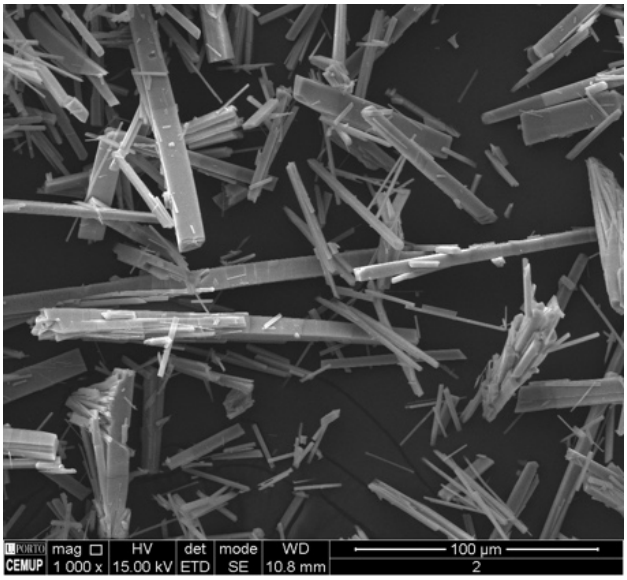

Figure 8. SEM image of Tb-MOF

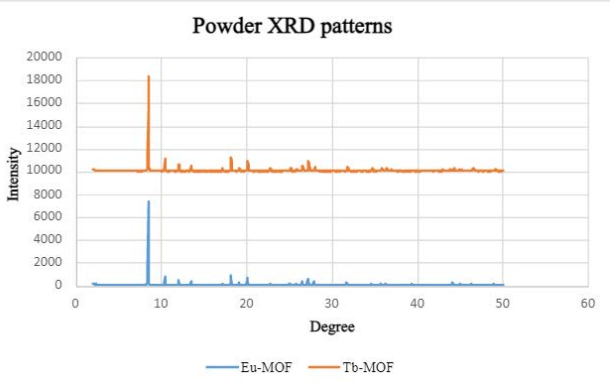

Figure 9. Powder XRD patterns of Eu-MOF (blue) and Tb-MOF (orange)

3.2. Results of Optical Detection

To evaluate if our samples are potential materials for the optical detection of water pollutants, we analysed their response to the presence of an antibiotic (Levofloxacin) and a heavy metal ion (Mn^{2+}). The luminescence properties of the materials were monitored with the incremental addition of aqueous solutions of both pollutants.First, we prepared two aqueous suspensions of our materials, Eu-MOF and Tb-MOF with a concentration of 1 mg/mL. The excitation spectrum of Eu-MOF shows the main excitation peak at 286 nm and the Tb-MOF has its peak at 301 nm. Both bands correspond to the excitation from the organic ligand. These values correspond to the ideal wavelength at which the materials emit luminescence more efficiently. The absence of peaks from the Ln^{3+} ions indicates that the excitation process preferably occurs through the BTC ligands. After recording the excitation spectra, we analysed the emission spectrum of each suspension alone and then with the incremental addition of antibiotic and manganese solutions and monitored the luminescence variations.

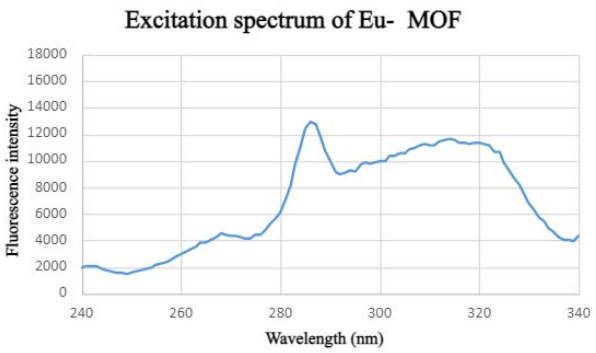

Figure 10. Excitation Spectrum of Eu-MOF monitored at 700 nm

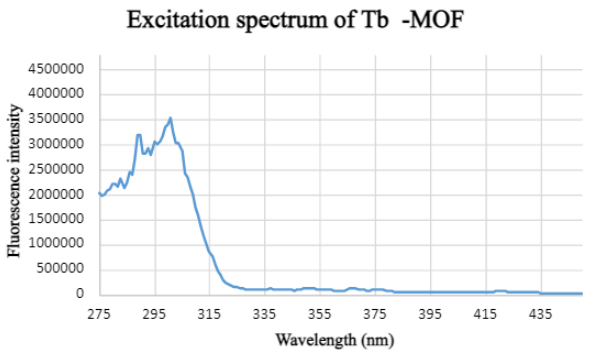

Figure 11. Excitation Spectrum of Tb-MOF monitored at 544 nm

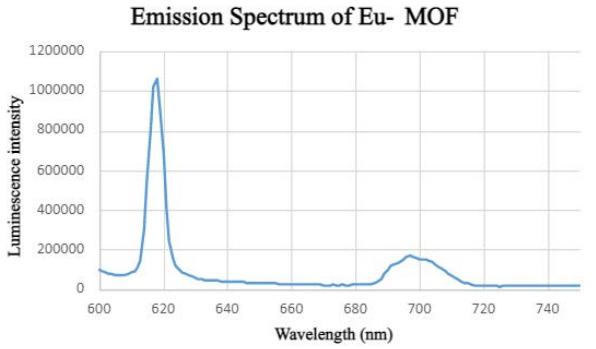

Figure 12. Emission Spectrum of Eu-MOF with excitation at 286 nm

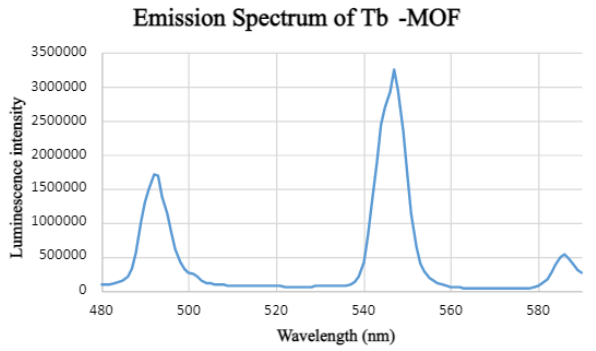

Figure 13. Emission Spectrum of Tb-MOF with excitation at 301 nm

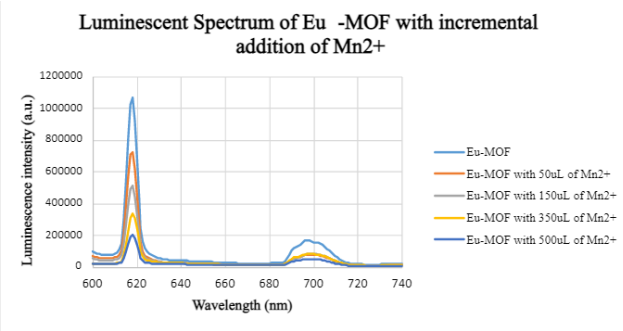

Figure 14. Luminescent Spectra of Eu-MOF with incremental addition of Mn^{2+}

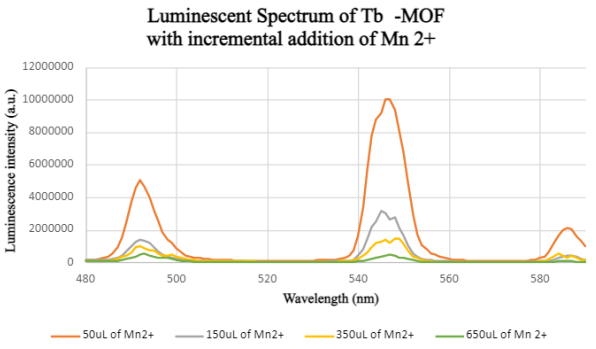

Figure 15. Luminescent Spectra of Tb-MOF with incremental addition of Mn^{2+}

Figures 14 and 15 reveal a perceptible reduction of the luminescence intensity of Eu-MOF and Tb-MOF with the incremental addition of Mn^{2+} (manganese solution). From this we can conclude that our compounds and its luminescence are sensible to the presence of Mn^{2+} ions.

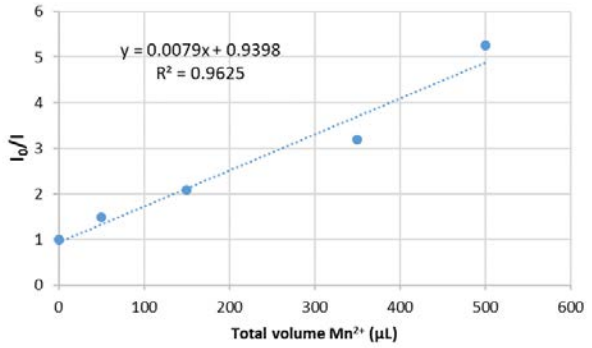

Figure 16. Variation of the relative luminescence intensity of Eu-MOF with the incremental addition of Mn^{2+}

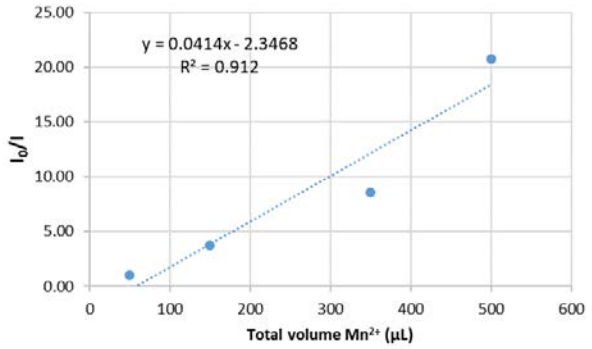

Figure 17. Variation of the relative luminescence intensity of Tb-MOF with the incremental addition of Mn^{2+}

The relative luminescence intensity of both Ln-MOFs varies linearly with the increasing addition of Mn^{2+} solution (Fig. 16 and 17). The results revealed a good correlation coefficient thus enabling the quantitative detection of Mn^{2+} in the studied concentration range.

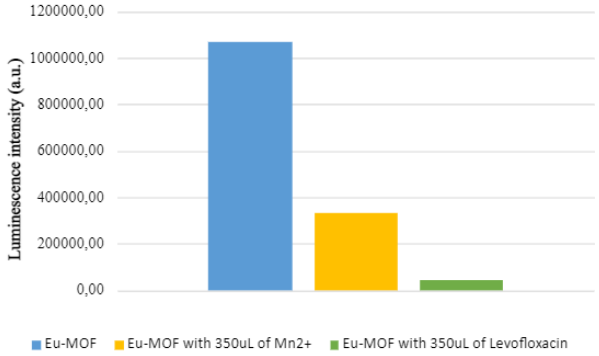

Figure 18. Chart comparing the luminescence intensity of starting Eu-MOF alone (blue), and after the addition of 350 µL of Mn^{2+} (yellow) and Levofloxacin (green)

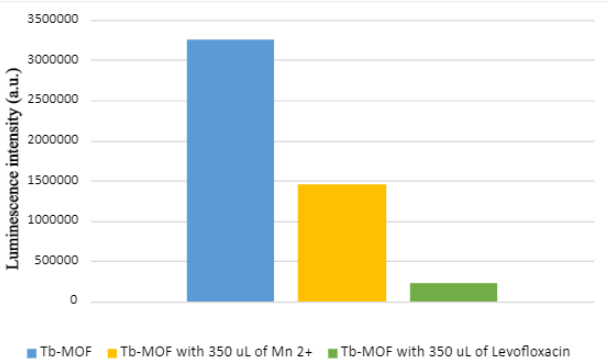

Figure 19. Chart comparing the luminescence intensity of starting Tb-MOF alone (blue), and after the addition of 350 µL of Mn^{2+} (yellow) and Levofloxacin (green)

The charts represented on Figures 18 and 19 show that our materials and their luminescence are more sensible to the presence of the antibiotic Levofloxacin than to the heavy metal ion Mn^{2+}. This is due to the fact that, for the same added volume of each model pollutant (350 µL), the antibiotic has led to a more significant decrease of luminescence intensity (quenching effect).

4. Conclusion

To conclude, the combination of lanthanide ions and metal-organic frameworks (MOFs) is an extremely valuable combination for application as optical sensors for the detection of water pollutants. The preparation of Eu-MOF and Tb-MOF was successfully done and these two materials have luminescent properties that variate in the presence of Levofloxacin, an antibiotic, and a Mn^{2+} solution. The results show their high sensitivity towards these pollutants, proving that they are suitable candidates for practical application as optical sensors.

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Candasat II: a Satellite in a Soft Drink Can

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Abstract. In this paper we describe the second space mission carried out at the IES de Candás; it consisted basically in designing, building and testing a small satellite in the shape and volume of a soft drink can.

The main challenge for the students is to find how to fit all the subsystems of a real satellite, such as power supply, different sensors, the control system and the communication devices, into this small volume, as well as the mechanical structure and the attachment of a parachute for the landing process. During their flight, our Candasat II uses radio communication to transmit data in real time to a ground station.

This activity has been developed by a group of high school students, in the framework of the CanSat competition [1], organized at international level by the European Space Agency (ESA) [2].

The student's team had to brainstorm their own mission objectives, ideas and constraints in order to try to define their own mission. Each participating team is free to design a mission of their choice, as long as they can demonstrate to have some scientific, technological or innovative value. The students should also keep in mind the limitations and requirements of the CanSat mission, and consider the feasibility (both technical and administrative in terms of time and budget) of their chosen mission.

The satellite has to accomplish a compulsory primary mission, consisting in measuring barometric air pressure and air temperature.

Additionally, a secondary mission incorporates a GPS for geolocalization and a camera used to obtain photographs and videos during the flight. A Raspberry Pi zero is connected to all devices to control all electronic systems.

By participating in this project, students developed 21st century learning skills like creativity, innovation, communication and collaboration, critical thinking and problem solving, as well as life and career skills like productivity, perseverance, leadership and responsibility.

Keywords. Space, Satellite, Raspberry Pi, STEM, Education, Robotics.

1. Introduction

This activity has been organized at international level by the European Space Agency (ESA), which supports a range of CanSat activities across its Member States (including Canada, Latvia, Slovenia and Malta), all leading to a European final event – the European CanSat Competition. The CanSat project, addressed tot secondary school students, involves different disciplines, mainly Technology, Physics, and Computer technology. An interdisciplinary approach is used to develop this small scale space project, as well as develops the ability to work in teams in a collaborative way.

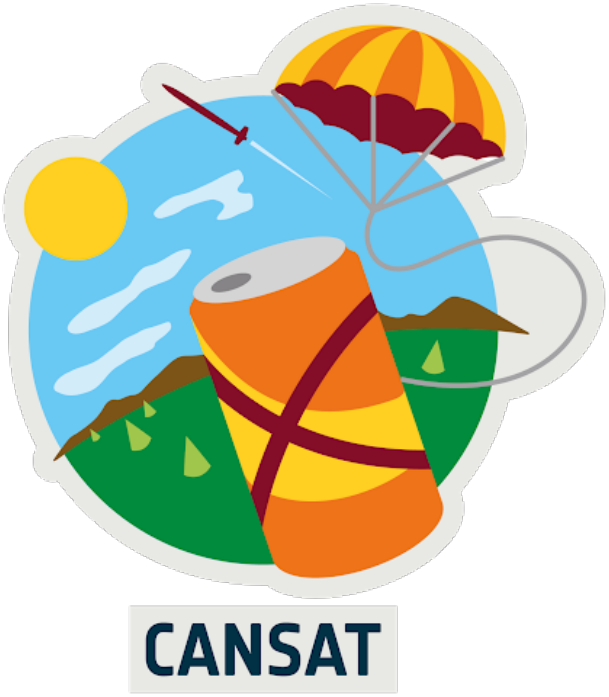

Figure 1. Logo of the CanSat project

A CanSat is a technological device that consists in a simulation of a real satellite, where all the components are located within the volume and the shape of a typical soft drinks can.

From the technical point of view, the

challenge for the students is to find the way to fit all the subsystems found in a satellite, such as power supply, different sensors and the controller, as well as the communication system, into this reduced volume.

Once ready for launching, the CanSat is then propelled by a rocket up to an altitude of approximately one kilometre, or dropped from a platform, drone or captive balloon. It is in this moment when the scientific mission starts.

This operation involves carrying out a scientific experiment and/or a technology demonstration, completing a safe landing, and followed by the corresponding analysis of the collected data.

2. Educational value

Besides the technical issues, the most important goals are related with the educational value and the outcomes and experience gained by students and the educational community.

By developing the different stages of the CanSat project, the participating student teams experience all the phases of a real space project, beginning from selecting the objectives of the mission, designing their CanSat, integrating the components, testing the system, preparing for launch, and analysing the scientific data obtained.

Throughout this process the most remarkable outcomes gained by the students are:

- Experience the benefits of learning by doing, and the subsequence long-term knowledge.
- The participants get acquainted with the inquiry-based methodology that is a characteristic of real-life scientific and technical professions.
- They acquire and/or reinforce fundamental Technology, Physics and programming curricular concepts.
- They can understand the importance of coordination and teamwork, a decisive aspect in their future tasks.
- The enhancement of the communi-cation skills is also important.

3. The CanSat Competition

The team must build a CanSat and program it to accomplish the following compulsory primary mission: For the European CanSat Competition 2020-21 launch campaign, this data must be stored at least every second in an on-board removable memory card. ESA personnel is the responsible to conduct the launches without the presence of the student teams (rather like a satellite launch campaign), therefore no live radio frequency reception is possible this year, as this is normally done by the student teams.

For the National Competitions, it is the decision of the National Organizers to consider whether the data should be stored in an on-board removable memory card and/or transmitted to ground.

During the post-flight tasks, the teams have to analyze the data obtained by the different sensors (for example, make a calculation of altitude) and display them in graphs (for example, altitude vs. time and temperature vs. altitude).

Figure 2. Students working in the CanSat project

The schedule of the different stages is as follows:

- 18/09/2020: The Competition is announced and ESA calls for proposals for countries with no national competition
- 30/11/2020: Deadline for submission of proposals from countries with no national competition.
- 16/12/2020: ESA announcement to the teams selected from countries with no national competition.
- January – 5 September 2021: National competitions take place.

- 16/04/2021 Critical Design Review Report, Student teams submit their Critical Design Review Report to ESA (only by teams from countries with no national competition).
- End of April 2021 ESA sends feedback of Critical Design Review to teams from countries with no national competition.
- 10/09/2021 Student teams submit their Final Report to ESA.
- 29 September – 8 October 2021 The Virtual European CanSat Competition takes place.

3. Technical requirements

The hardware and mission should be designed according to the following requirements and restrictions:

1. All CanSat components must fit inside a conventional soft drink can (115mm high and 66mm diameter), except the parachute. Outdoors, radio antennas and GPS antennas can be mounted on the top or bottom of the can, depending on the design, but not on the sides. The antennas, transducers and other elements of the CanSat may not exceed the diameter of the can until it is released from the launch vehicle. The rocket payload area generally has 4.5 cm of space per available CanSat, along the axial dimension of the can (i.e. height), which should accommodate all external items, including: parachute, accessories parachute attachment and any antenna.
2. The mass of the CanSat should be calculated between a minimum of 300 and a maximum of 350 grams. The lightest devices will need to carry additional ballast in order to reach the minimum required mass limit of 300 grams.
3. The use of explosives, detonators, pyrotechnics and flammable or dangerous materials is strictly prohibited. All materials used must guarantee the safety of personnel, equipment and the environment.
4. The power supply of the CanSat must be obtained from batteries and/or from solar panels. Systems must be prepared to stay on for four hours straight.

Figure 3. Gant diagram showing the different stages and tasks

5. The battery should be accessible so that it can be easily changed or recharged if necessary.
6. The CanSat must have a perfectly accessible general power switch.
7. The CanSat must have a recovery system, such as a parachute, that can be reused after launch. The use of brightly coloured fabrics is also recommended to facilitate the location of the CanSat after landing. It is recommended to include a location system for facilitate the location (pager, radio beacon, GPS, etc.).

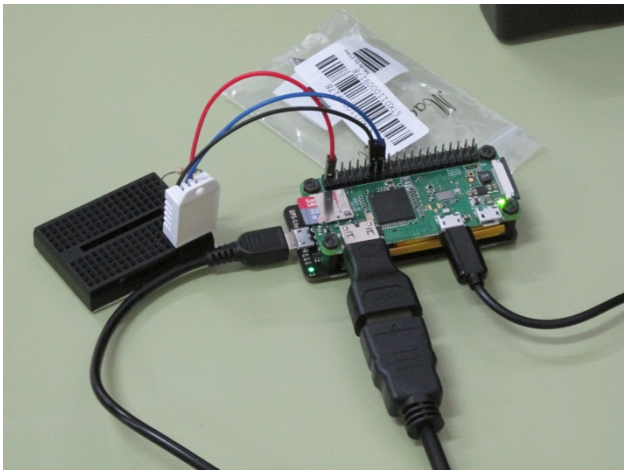

Figure 4. Experimental setup during the preliminary tests

8. The parachute connection must be capable of withstanding a force of up to 500 N. The robustness of the parachute must be tested to ensure that the system will perform as intended.
9. To promote the recovery, a maximum flight time of 120 seconds is recommended. If a controlled landing is attempted, a maximum flight time of 170 seconds is recommended.
10. In order to recover the CanSat, a descent speed of between 8 and 11 m /

s is recommended. However, the speed of descent must not be less than 6 m / s or more than 12 m / s for safety reasons.

11. The CanSat must be capable of withstanding an acceleration of up to 20 g.
12. The total budget for the final CanSat model must not exceed the amount of 500 euros. The equipment of the ground stations and the other related instruments that do not fly will not be considered within this specified budget.
13. In case of having sponsors, all the elements obtained through them must be specified within the budget according to their real market price.
14. All teams must respect the frequency assigned to them during the launch campaign. The range of frequencies allowed varies depending on the country in which the meeting is held and will be communicated in due course. Teams are advised to pay attention to the CanSat design in terms of hardware integration and interconnection, so that the radio frequency can be easily modified if necessary. In the national launch, between four and six Cansats will be released at the same time. It is recommended to take this into account when designing the communication system, including some type of data encoding, in order not to confuse it with that of other equipment.
15. The CanSat should be ready to fly upon arrival for the launch campaign.

4. Scientific project

We have decided not to go too far from the recommended project requirements. With all the devices inside the cylinder, we can calculate different parameters such as pressure, temperature and humidity, as well as taking photos taking advantage of the great height reached. All this information from the sensors will be consulted directly from the ground station at the moment, in this way, we can compare our data with the official ones, looking at the precision of our experiment. The images will be recorded on the microSD card inserted in the slot of the Raspberry Pi Zero.

With the primary mission we intend to analyse the properties (pressure, temperature and humidity) of the atmosphere and its variation with the altitude.

With the secondary mission we intend to take advantage of the images, in combination with their positioning, for a study of the orography and the terrain. Although in this case, due to the shortness of the launch, the information obtained is not very useful, the system could be implemented on another type of support, such as a drone or a stratospheric balloon and thus be able to obtain information for its use in relation to aspects such as fire detection and monitoring of their evolution, as well as the study of invasive plant species.

5. Hardware

5.1. Power supply

The satellite obviously needs an internal battery to obtain the electrical energy for the different modules.

Figure 5. A lithium battery with regulation and measurement elements is used as a power supply

Lithium batteries have very good characteristics and are very frequently used in this type of system.

We have chosen this power supply because it is small in size, has sufficient power and capacity, and is affordable.

Our power supply will be a UPS Lite V.1.2. Their characteristics are:

Table 1. Characteristics of the power supply

Material	Polymer of lithium
Capacity	1000 mAh
Charge current	Max 400 mA - 5V
Output current (no external source connected)	Max 1.3A - 5V
Output current (with external source connected)	Max 2A - 5V
Capacity measure	Error ±2%, and ± 3mV
Switch	Yes
Charging connector	Mini-USB
Connector to Raspberry Pi	Pogopin 5 pin

5.2. Control system

The core of our project will be a Raspberry Pi Zero 1.3. We have decided to use this device despite other more conventional devices, like Arduino, due to its greater computing ability and the number of functions and more facilities to work with it.

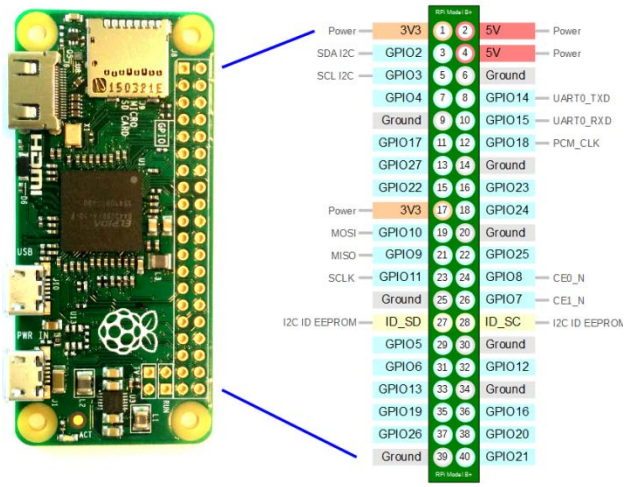

Figure 6. General view of the Raspberry Pi model Zero, with the identification of the GPIO pins

The Raspberry Pi is a single-board computer developed by a UK-based charity organization, called the Raspberry Pi Foundation. In their first steps, it was designed to provide young people with an affordable computing option to learn how to program. During the last decade, it has developed a massive following in the maker and DIY communities, because of its general-purpose input–output (GPIO) pins, as well as its compact size and full Linux environment.

Table 2. Technical characteristics of the Raspberry Pi Zero

Integrated processor	Monocore **ARM 11** Broadcom BCM2835 @ **1 GHz**
RAM	**512 MB**
Card reader	**micro SD**
Video	Mini HDMI output
Pines	GPIO 2x20 soldered s
USB	Two USB ports, one of them used for the power supply (not included)
Camera port	1 CSI port to connect a surveillance camera
Connectivity	Wi- Fi 802.11 b / g / n and Bluetooth 4.1 BLE (low power consumption)
Dimensions	65 x 31 x 5 mm
Power consumption	100-230 mA
Voltage	5 V

5.3. Communication module

After having prepared all electronics needed to carry out the Primary Mission, there is one vital step: the information that the CanSat collects must be sent to a ground station. To be able to do this, we need to take a look at the components we can use to transfer data and how electronics communicate.

Figure 7. The pair of devices of the communication module: one attached to the computer and the on-board device

For communication and data transfer we used a pair of modules working in the radiofrequency bands around 450 MHZ, equipped with an external antenna. After testing different devices, we decided to use a CC1101, although we worked in the preliminary tests with the module NRF24L01, as well as

with the APC-220, but the results were not very satisfying in terms of integration with the hardware and the transmission capacity.

The communications wireless transceiver is composed by two identical elements of hardware; one element is included in the payload on board and the other one remains integrated in the ground station, connected to a computer through the USB port.

Table 3. Characteristics of communications module

Working frequency	433 MHz
Feeding	2.1V to 3.6V
Consumed current	15.16 mA.
Transmission range	Up to 300m
Communication interface	UART / SPI
Baud rate	38400 bps.
Receiver buffer	64 bytes.
Work temperature	-40 ° C to +125 ° C.
Channel quantity	126
Output signal power	Up to +12 dBm for all frequencies

5.4. Physical sensors

For the pressure we will use the BMP180, which also allows us to measure the temperature. This system uses both temperature and pressure measurements to be able to measure the altitude above the sea level. The BMP180 is very similar to the 280, the difference is that the precision is 1 HPa in the 180 and 0.12 HPa in the 280, although the current consumption of the 280 is higher and we do not require high precision.

To measure temperature and humidity we will use DHT-22. It is a very simple and easy to use device that has a high quality precision, above DHT-11.

5.5. Geopositioning module

For the secondary mission, a geopositioning device was used to locate the satellite after landing as well as to track the trajectory during the flight. Our GPS system will be a NEO6MV2. This will allow us to locate our device at any time thanks to its 9600bps transmission speed.

It is a GPS receiver that has a high power antenna and has an EEPROM memory to save data and a battery to support the configuration of the module, which allows it to receive signals from satellites. It is compatible with Arduino, PIC, AVR, Raspberry and other different commonly used microcontrollers.

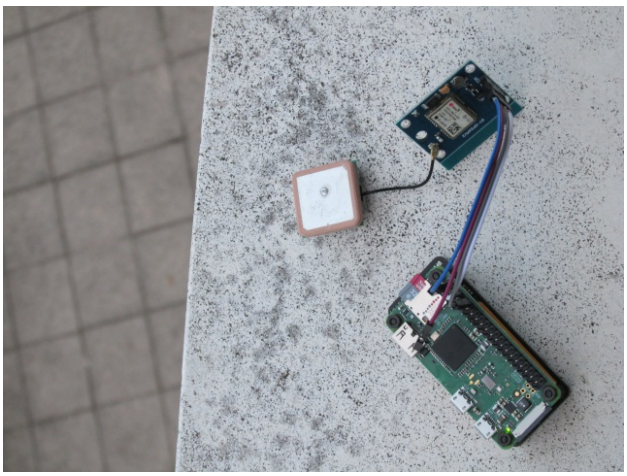

Figure 8. The GPS module attached to the Raspberry Pi

Table 4. Characteristics of GPS module

Supplyvoltage	3.3v-5v
Antennasize	25mmx25mm
Antennatype	Ceramics
Modulesize	23x30mm
DC	45th
BaudRate	9600
Hotstart	1s
Coldstart	27s
Operatingtemperature	-40~85 ºC
Errorrange	5m

After considering different options for this purpose, the election of this model was based on the good combination of different parameters, mainly, size, performance and economical cost.

5.5. Image acquisition

Figure 9. The camera used to record images and videos

To take images we used a 5MP camera for Raspberry Pi Zero. The camera is attached to the controller using a ribbon cable by using the camera module port, pulling up on the edges of the port's plastic clip.

This camera is easily handled by the raspberry Pi, by using simple programming instructions and allows taking and recording pictures and videos during the trajectory of the satellite.

Table 5. Characteristics of the camera

Sensor, type	Mini vision OV5647 Color CMOS QSXGA (5-megapixel)
Sensor Size	3.67x2.74mm (1/4 inch format)
Number of pixels	2592x1944
Pixel size	1.4x1.4 um
Lens	f = 3.6mm f / 2.9
Vision angle	65-75 degrees
Field of view	2.0x1.33 m to 2 m
Equivalent SLR lens full frame	35mm
Fixed focus	1 m to infinity
Video	1080p at 30 fps with H.264 (AVC) codec

5.6. Electrical design

A protoboard was used for the preliminary tests; nevertheless for the real Cansat, it can cause some problems related with disconnections due to the high values of acceleration; therefore we decided to solder the cables directly, protecting them by means of a heat shrink tube, to avoid eventual imbalances produced by vibrations and strong accelerations during take-off, release and landing.

In order to analyse the power consumption of the complete satellite during the operation, a power budget should be performed, taking into account the electrical characteristics of each individual element and the variations depending on the operation conditions.

By providing a power budget, detailing how much power each component consumes and battery capacity, our team was able to make an estimation of the power consumption and the lifetime of the batteries. Taking into account the lithium batteries we used, this table gives information about the lifetime of the satellite and allows ensuring the reliability during the flight.

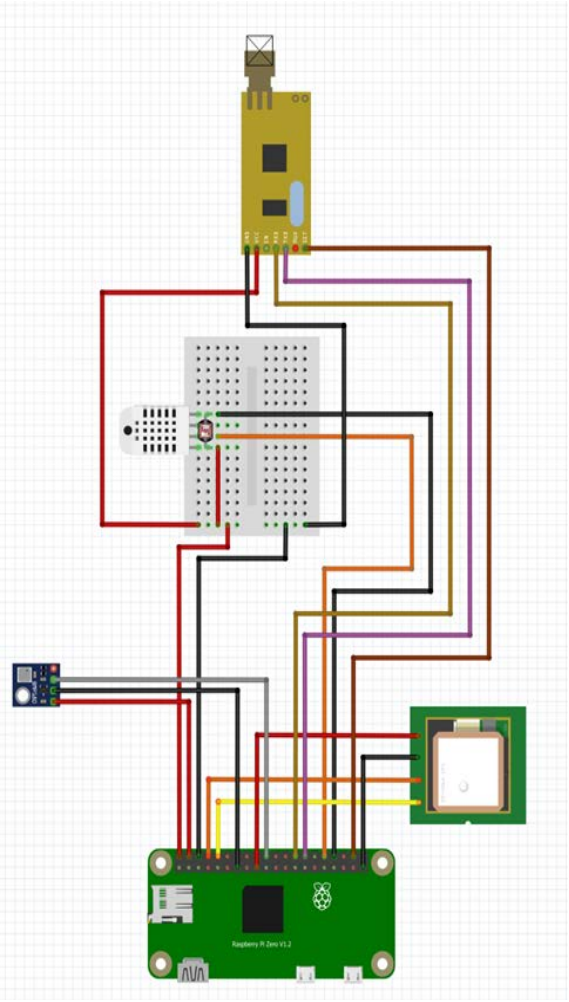

Figure 10. Electrical circuit diagram

Table 6. Power budget

Element	**Intensity**
Raspberry pi Zero W	230 mA
Gps	45 mA
DHT22	2.5 mA
BMP180	0.65 mA
Camera	<50 mA
CC1101	35 mA
LED	20 mA
TOTAL	**383.15 mA**
Battery capacity	1200 mA h

5.7. Mechanical structure

The last, but by no means least important, step to building our CanSat was to build a container where to house all of the electrical components for the primary and secondary missions. Not only does this protect the components from the different forces it will

experience during launching and landing, it can also offer some protection against the environment, such as a rain or extreme temperatures.

The mechanical structure of the CanSat includes two main components: the internal structure and the container.

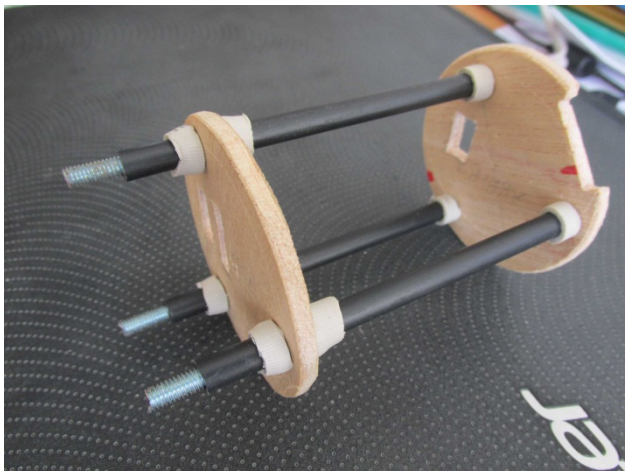

Figure 11. Internal structure

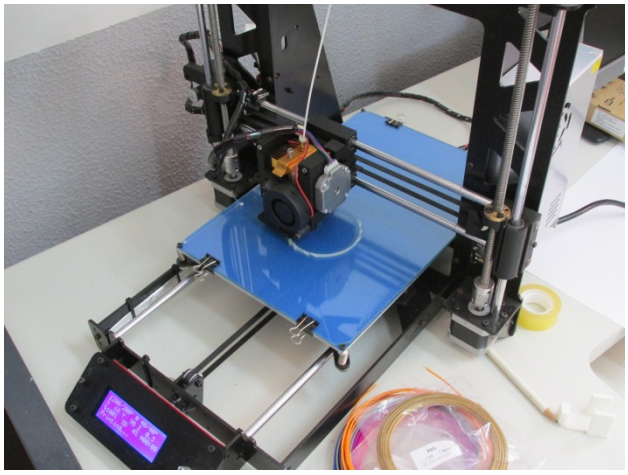

Figure 12. 3D printer working in the elaboration of the container

For the inner structure, we incorporate the idea of sustainability concerning the election of the materials, together with the mechanical properties. This element consists in three M4 steel threaded rods, conveniently recovered by polyethylene in order to achieve the desired electrical isolation of all components allocated inside. These three rods fastens two wooden platforms which keeps all the components (Raspberry and power supply, sensors, GPS, radio module and camera) in the size of a soft drink can.

The second part of the structure is the container, with external dimensions of the can, is a cylindrical box with a diameter of 65 mm and a heath of 115 mm.

Figure 13. The external container made of black PLA

Table7. Mass budget

Element	Weight
Raspberry pi Zero W	11 g
Gps	17.6 g
DHT22	4 g
BMP180	3 g
Camera	18.1 g
CC1101	14 g
LED + resistor	2 g
Wiring + welding	20 g
Drums	30 g
Container	60 g
Threaded rods + nuts	65 g
Brackets	35 g
TOTAL	279.7 g

The material chosen for the construction of this container is black PLA. This structure has been manufactured by using a Prusa i3 3D printer. The design of the mechanical structure was carried out using SketchUp software, a

free tool which allows intuitive handling of 3D editing tools. The Ultimaker Cura v4.9 software was used for the elaboration of the model to be printed.

Moreover, it was necessary to provide a ballast to reach the minimum mass of 300 g of the satellite, as was established in the conditions of the competition.

5.8. Parachute

The landing system incorporates a hand and homemade conventional parachute made of waterproof polyester taffeta.

The design, as well as the elaboration of the parachute was made by the students; after making a comparison of different shapes and adjusting the parameters of descent rate depending on the payload mass and the shape and dimensions of the parachute.

Figure 14. Launching a simulation of the satellite with the parachute

The parachute has a cross shape due to the combination of the performance and the simplicity of the elaboration procedure. The threads are made of 0.23 mm thick Nylon rope.

With these characteristics we calculate a coefficient of friction between 0.6 and 0.8. Several tests have been developed to prove their reliability, by launching the top floor of our school and filming the fall and, then, analysing the recording frame by frame to determine the descend rate.

6. Software

The operating system for the Raspberry Pi is stored on a microSD card. There are different options to install an operating system on a Raspberry Pi platform, although the most common is Raspbian, the officially supported Raspberry Pi operating system, which is based on Debian Linux.

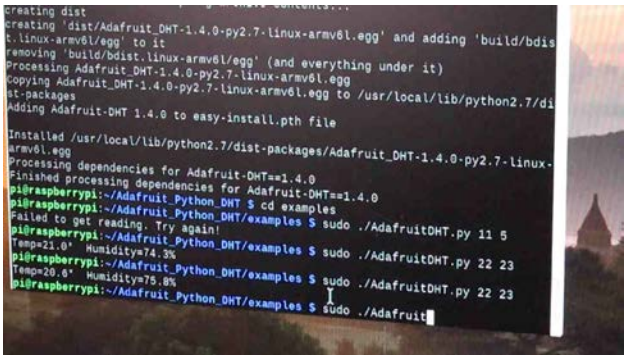

Figure 15. Appearance of the Raspbian shell showing the measurements of temperature and humidity from sensors

Besides the background software, we need to use a programming language to set up all the components connected to the hardware and to read data from sensors, store in the SD card and transmit to the ground station through the communications module using radiofrequency.

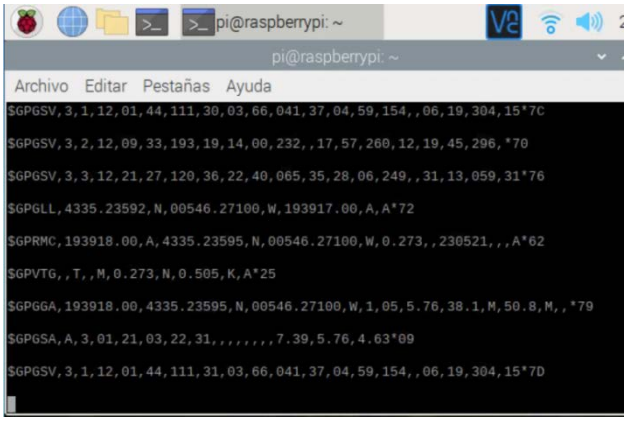

Figure 16. Appearance of the coordinates and complementary data provided by the gps module

For this purpose, Python is a fantastic language for programming the Pi, thanks to its ease of use and access to hardware, including GPIO. This powerful programming language is easy to use (easy to read and write) and, with Raspberry Pi, lets us to connect all components of the satellite.

We had to take into account that, on Raspbian, a Python program usually needs external libraries in order to facilitate the handling of the different modules. Python syntax is very clean, with an emphasis on

readability, and uses standard English keywords.

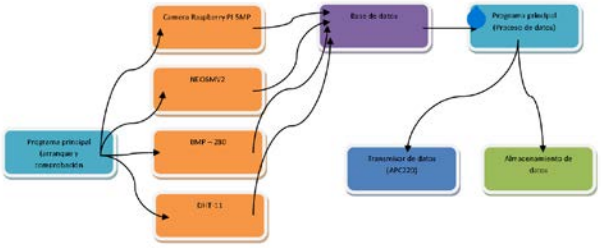

Figure 17. Blocks diagram of the software

The easiest introduction to Python in this platform was performed by using Thonny, a Python3 development environment, available and natively included in Raspbian. Thonny gives us a REPL (Read-Evaluate-Print-Loop), which is a prompt we could enter Python commands into. Because it's a REPL, we even got the output of commands printed to the screen without using print in the Shell window.

7. Conclusions

The above mentioned activities contributed decisively to engage students, teachers, parents and external institutions and individuals on STEM education.

Our goal is to provide our students with the best possible insight in the field of natural science, while they are thrilled about knowledge, discovering and eager to develop long-term activities.

Discover a whole new world with fascinating learning scenarios and breathtaking moments all around the STEM related subjects is possible with the aid of the weather balloon and a lot of enthusiasm.

Due to the characteristics of this activity, the several disciplines have been cooperating collaboratively and working together, in order to accomplish the successful realization of the satellite.

- Computer science: with a data logger, students are able to code with Raspberry Pi and Python programming language and measure and record many different parameters, like temperature, pressure, altitude or the position. Later they can evaluate the data, make diagrams and presentations.
- Mathematics: is an essential part of this space mission and indispensable for its success. The major parts will be to calculate geometrical quantities, physical and statistical calculations, etc.
- Physics and engineering are the most directly involved fields, including the electronics design and assembly, materials properties, forces, energy conversions, etc.
- Physical education, students develop skills in open-field orientations and parts assembling by using different types of rope knots.

In the framework of secondary education, the field of space exploration at experimental level still remains inaccessible for pre-university students. In the last decade some projects raised in this area and this is our step which should be continued in the next years.

As can be easily deduced from his name, this project, called Candasat II, is the continuation of the previous one, called Candasat I, consisting in a payload driven by a high altitude balloon filled with helium. The technical issues of this first project were simpler; nevertheless, the logistics have been more demanding due to the lack of the external support provided by the department of education of the European Space Agency.

8. Acknowledgements

The collaboration of Dr. Germán León from the area of Signal and Communications Theory of the University of Oviedo was very relevant in the field of radio communication, as well as the help of Gijón Maker Centre with the 3D impression of the structure.

The development of this project would be impossible without the support of ESA Education and ESERO, as the institution responsible for the Spanish competition.

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Science, Play and Progression in Early Years

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Abstract. Play is a stage in learning to be an adult and develops understanding, a problem solving ability and skills as they do so. It is progressive with practice and development. Observations are the beginning followed by questions and interactions and interpretations at this early stage where a child's interest is 'caught' The interactions follow a Play Cycle similar to the one that occurs in inquiry science investigation in school. Observations indicate that this same progression of internet- active inquiry using senses, particularly touch and vision, is replicated in any play situation.

Keywords. Progression, Play, Science, Pre-school.

1. Introduction. What is play?

Not all animals play. It is observed in a few species and varies in form Biologists have suggested that the developmental play in warm blooded animals may be the result of their having more energy than cold blooded organism which spend their energy on food searching. Smith, [1] provides a comprehensive account of play in other animals and in humans. However, the youngest animals, including humans, have to learn to be one of their kinds. Prehistoric children played with a variety of objects, man made by themselves which is similar to the interactions and changes effect on the environment by other mammalian organisms that older children's play with objects is similar and an important stage in apprenticeship for their adult roles. Indeed, play is found relevant amongst children as a distinct apprenticeship for adulthood by researchers [2] studying play in children across diverse cultures.

UNESCO defines Early childhood years between birth to eight years old. Play is most often considered by Western society to be an activity of children, particularly in early childhood, the early years. What however is earlychildhood, the stage where play is often a predominate occupation? My particular focus is on the pre formal school child, 0 to 5 years of age in England. And their free choice play when they choose with what to interact from items provided.

Play is firmly believed that is it children's work, [3. p 14] "Science, during early childhood, is more than play? It is serious business. If we fail our children and students in science, the reasons may include lack of appropriate experiences during early childhood"

However, adults talk about their own play, with a different and recreational meaning as opposed to their occupational work, referring to playing various games, in terms of recreation from paid jobs in particular, in their leisure time. Often parents and other adults consider children's play, of any kind, as 'Just Playing' and a waste of time ([4]. It is salutary to remember [5] that "What a child can do with assistance today she will be able to do by herself tomorrow". Progression is an integral part of a child's learning and development. Whilst there is a wealth of literature about play and early childhood very little reports on the development of science learning processes, understanding and capabilities [6]. Many young mammals play and researchers as the young practicing skills needed for survival in adulthood. What do human children do? They play, with what interests them if allowed. They explore their world and compile the experiences beginning to develop their personal science capital from the earliest of age. They experience STEM (Science, Technology, Engineering and Maths) in their everyday activities, STEM in action, so experience these phenomena without linking with the academic knowledge. Thus, establishing a fund or personal repertoire within their knowledge boundary as their scientific capital develops from their experiences not from being taught a curriculum as in formal learning.

The international play association (IPA) believe that play is vital for a child's development. So is the environment in which a child exists. The first 1001 days of life from conception to 2 years are the most critical time for the developing being. This is the pivotal stage in a child's life where they are shaped and influenced by the environment and people around them, but most importantly their mother or carer playing with them. The effect of the

community and culture within which they live. Is also important in the development of their individual and societal understanding. The importance of the very youngest of children being able to play is vital as is meeting other children and learning co-operate at later years in the pre-school stage. Local communities in many countries provide play areas with purpose built equipment on which children can play whilst exploring their personal limits. Increasingly this is a trend of encouraging risky play where children can safely find their limits [7]. Children in formal schools where the children 'go out to play' have a break from formal school work and may occupy this break time with games involving other children and experience active physical activity.

2. Categorisations of Play

There have been various categorisations of play. None particularly look at the science, maths and engineering aspects of the child's play. A taxonomy of Children's play, based on the work of Hutt [8], identified three categories: Epistemic behaviour, Games with rules and ludic behaviour. However, a categorization STEM play into genre [9].Play is not of one kind nor is it constant from birth to whenever. It is not static, it progresses. One of the researchers into the beginnings of British children's play [10] introduced the 'Treasure basket' where items were placed in basket or another container for the non-mobile child, exploring artefacts. She suggested providing a selection of such in a basket or other container (a treasure basket). Children explored the properties of materials, through touch, and manipulation for example). However, once mobile, any environment in which children are becomes a site and opportunity for children to indulge in heuristic play. In this play, which develops into older children picking up and exploring items they see whether in a shop, a home or outside. It is also an instance of what was named free-flow play, [11], where the children move feely from one activity to another, as they do in unstructured play groups, such as the one in which the observations reported in this paper were made. I advocate a STEM bag for very young children with simple items which the child explores for themselves, thus encountering shapes, materials, textures, colours and other properties such as rolling, dropping, some of the STEM basics.

The youngest of children observe think, investigate and are intuitive scientists. Learning is a constructive gradual accumulation as more is learnt. From a science point of view playing with toys or everyday phenomena is Inquiry based learning. In any structured play whether children are left alone to choose what they do and how they use provided items. Children will "Do it their way", not as adults who designed the items and would expect them to be used. Instructional play is an adult's response to this tendency of a child employing their natural way of finding out, inquiry, its self-will! Adults often intervene either to tell the child what to do or give some information retrieved form their STEM experience and knowledge but of course instruction is necessary in certain instances requiring safety rules and skills. Free choice play is similar to the process of STEM inquiry. Observations trigger questions and a strategy is planned, reflecting previous needed for investigation and action and playing together with assessing the outcome. Watch children working through this process!

3. Play is not a single entity

Play has many dimensions and form. There is unstructured and structured play. Unstructured play is absolutely is child led, free choice and is unstructured as they interrogate with thoughts and actions that with which they are playing' Free choice unstructured play is therefore when where there are no 'toys', only resources that the child can find outside, or/and inside: This is a variety of free flow play in a development of heuristic play.

Structured play is when artefacts are purposely available and whilst the child chooses how to interact she didn't find. These may be everyday items as in classic heuristic play situation such as the treasure baskets or STEM Bag, or they may be artefacts, such as toys, or play equipment designed by adults for children, who do not necessarily use them as 'they should' but utilise them as they feel right for them. Designed by grown up wish their ideas- not by children with theirs? Artefacts of reduced size used for re-enactment of adult activities, such as cooking, artefacts are often available. Small reduced size, simpler versions of adult items such re-enactment play serves as facilitated play in the genre of apprenticeship for adulthood and involves many identifiable aspect of STEM However, much as cooking

utensils, other tools and items such as cookers. Such of such play spontaneous and free choice. Mediated play is recognised when toys are available. The children choose with what they are 'playing', moving often from one to another. However, Facilitated play when specific items are made available and the child is expected to 'play' with, but in fact often adapt the items for their own exploration.

Instructional play is where the aim of the adult facilitating the interaction is for the child to try an activity or artefact and lead into developing some specific skills and concepts. Instructional play has its place too where there are rules, skills or techniques required to use the play object of the naturally occurring phenomena [8]).

The form of spontaneous free choice aspects of a child's own play is the most informative genre off play for assessing a child's capabilities. It is interesting to note the development of the adult/child interaction and the development from simple observation to developing cued thinking. Effectively, we are looking at learning narrative. In a similar way to learning journeys which many formal pre-school establishments compile for each child in their care. Observations of preschool children playing [12] showed that the science actions to occur in play and identified such. The observations reported here are in the same line of observational analyses and interpretation. The key aspect is that the actions are the choice of the child, their choice. I acknowledge that the very nature of the situation and object (Animal, plant or mineral) afford to the young child, are the result of the curiosity and interest but as they develop also in their remembrances of past experiences from their fund of STEM actions and effects. Such can be recorded pictorially in a journal of the child's learning journey, at home or preschool, and reviewed with the child after a time lapse [13].

Play is the foundation upon which future learning is built. Thus it is essential for a child's mental development. Children's play involves their senses, very much in the first years which were called the sensory motor phase. Another researcher [14] recognised and developed the idea of social constructivism, but very young children play alone. I notice children about 3 years begin to collaborate after a stage of playing alongside another child. Sometimes adults tell the child how they should use the material for example, this is directed or guided play but is more often Instructional. Adults often intervene either to tell the child what to do or give some information retrieved from their STEM experience and knowledge. However, some adults work as a 'significant other,' prompting the child to think further and, in some cases, interacting in play with an unfamiliar material of situation, absolute co construction between child and adult occurs.

4. The Play Cycle: Interactive and Progressive

Play is not uniform in several ways. First of all, the term play is a superordinate category covering the activities of young children observing and interacting with phenomenon, natural such as the weather or constructed such as everyday implements or items, toys, created specifically for children by adults, and frequently not used in the way the adults envisages. Secondly, it is progressive in understanding; capabilities and skills experiences are honed and developed. Play is not the same from the earliest years to adult hood. Play is progressive as skills and understanding. Thirdly, play interactions depend on the interest of individual children.

The initial but critical stage in a child 'playing' is that their interest is 'caught' and subsequently maintained so they enter into an interaction with the phenomenon. This which is the basis of the person-object theory of interest (POI), where the initial interest elicited by the first encounter is caught. This theoretically is the Theory of interest, [15-17]. The interest represents a particular interest, particular to that child, between the child and then phenomenon, usually an object. It included initial attention to the item, interacting in a task and if included, requires maintained curiosity and engagement. Whilst widely applied in museum work with visitors at exhibits, this theory is pertinent to play.

Much 'science' focused play and indeed activities in play groups and nurseries with constructed equipment are of a physical science manifestation involving pushes, pulls, essentially using sources which are powered by the energy from the child's play social action.

Hence I developed the play sequence or

cycle.

The play cycle has distinct identifiable stages can be identified in observing children at play. There are variations depending on the science are in questions. Above, is a toddler the child is intrigued and explores the artefact they encounter, phenomena.

Figures 1. The Play Cycle [18]

When the attention of the child is captured as young children are naturally inquisitive and their attentions caught by a wide verity of phenomena. Exploring materials such as mud and sand or dusty soils often causes them to stop and feel,

Biology and aspects of Earth and environmental science are not of the same type and are particularly observational to greater extent. Such biological and earth science encounters and progression are not the focus of this paper. The majority of play observed is not biological in nature [19].

5. A case study – Progression in investigating a play material- playdough

This example is focused on inquiry into the properties and use of play dough by a group of children brought to a local Church of England Mother and toddler Play Group held in the Parish Centre after a short service in the Church The children who interacted ranged from an 11 months 30 days, it was his birthday the next day, to a boy of 2 ½ to a study and half year old girl and a boy.

Some attendees were child carers with several children who take photographs of their charges interacting which are sent electronically to the parent in the daily message. When granted permission we can take photographs of children involved in a task, but there are children for whom photography by others is not allowed. We sometimes photograph the action with hands or the end result, not the face of the child. Some of the adults will share their photographs and some mothers come and update us on cavities carried out at home, structured, such as planting bulbs, cooking together, or the child's spontaneous free choice action.

5.1. The setting and the material

The local Church of England, and the Head of the Church primary school, where we were both known because one of had taught at the school and was a regular attender at the church and the otter had been a head in the local authority, considered, after hearing of our initiatives in this area, that they would welcome and collaborate about hosting in the Mother and Toddler group held in the parish Centre in the English term times after the special Toddlers service officiated at by one of the Parish team. A teaching assistant at the school, a former graduate chemist researcher, is the liaison with the school which provides items and handouts. Servicing and attending this activity is part of her agreed work.

Tables are set out in the Church Hall on which the everyday science items are put. Other regular toys such as coloured, clip together brightly primary coloured blocks, balls, play kitchen, an assortment of small plastic animals, a tunnel to crawl through, some pictorial fiction books are also put out for the children. Attendees range from babies though to reception age. Every few years the predominate age of children is up to 3 years and our activities and expectations are modified accursing to the ages of the children.

On the science tables where these reported instances were observed, there were lumps of home-made playdough on laminated mats, a selection of 'tool' from purchased set left over from our own parent days and a selection of biscuit conjurers in a variety of shapes.

Play dough menu obtained from [20] (adapted a little). What you need:

- 1 cup of flour (whatever kind you have on hand)
- ¼ cup of salt
- 1 Tbsp. cream of tartar (optional)
- ½ cup of warm water
- 5 drops of natural food colouring(if you want a colour)
- Bowl, airtight storage container, rolling pin.

What you do:

Mix together the flour, salt, and cream of tartar. Mix together ½ cup of warm water with a few drops of food colouring. Slowly pour the water into the flour mixture, stirring as you pour. Stir until combined, and then knead with your hands until the flour is completely absorbed. If the dough is too sticky. Add more flour until it doesn't stick at all. Roll it out or make it into spheres if you want.

Repeat process for which ever colours you want to make. Play dough stores in an airtight container

5.2 Procedure

We observed the children I as non-participant observers. We noted their physical responses, body language and verbal narrative in older children as the added to their learning journey and experience, in this case of a material and the actions they could make with it. Other sessions have focused on sound, light, forces, floating and sinking, fruits, seeds, parts of plants, external parts of human body, and matching animals to each other. Children also play with other items regularly put out such as Lego, toy kitchen, blocks and wheeled items such as a toy truck and push chair as well as some very early year's books.

6. Children's responses. Showing progression with development and experiences

Three small case studies of four different children, a stand-up alone toddler, a confident toddler and aged 3 who'd done this before are reported. This was an unusual happening with no parents interacting.

6.1. Jack

The next day was Jack's first Birthday. At the end of the session everyone sang "Happy Birthday" to him.

He could stand and pulled himself up to the table after sitting on the floor under it exploring, largely with is mouth and fingers, a semi-circular wooden block. Once he had pulled himself up to the table he delighted in poking and pushing his finger into the play dough. He then found he could pull off bits. Eventually he 'collapsed ' again to the floor with small pieces of playdough which he had pulled off before he returned to the floor! His mother watched but did not interfere until has indicated he was intending to explore the properties of the play dough with his mouth.

6.2. Harry

Harry is a boisterous two-year-old, came into the hall with his mother, who was setting up the activities and thus not attending church, Harry saw the play dough and rushed as fast as he could to the table and took control of a lump. He held the lump on the table and with one of the plastic knives proceeded to slice off flat pieces which he then piled then up, each one as he produced it, into a stack. His 'slices stack' is shown in the inserted photograph of the play dough table after he had finished but before other children arrived. His 'stack is shown in the photograph below.

Figure 2. The playdough table

6.3. Hugo

An older toddler of 3 yrs. delighted in finding

the play dough. He pulled off pieces, indicating he was familiar with this property of the material, and rolled them into balls and then found a bowl into which he placed them. "Peas" he said. His mother watched and said he loved using play dough. She did not allow it (or water play) at home because it made such a mess but brought him to such groups to enjoy those materials.

6.4. Amelia

A well-built, boisterous girl of between 3 and 4, with a shock of curls rushed to the table, recognised the material, poked her index fingers into a large flat piece of play dough, exclaimed great satisfaction as she did so, experience over, she ran off.

7. Summary of interactions and STEM concept

These children used their instinct and in the case of the older toddlers probably his previous experience, to manipulate the material. There was a progression of actions and skills with age and development of children. The science involved is summarised in Table 1.

Table 1. The science (STEM) actions of the children in this observational study

Action sequence	Action	Tool	Experience	Science idea
Initial encounter Materials basic properties	1.Pushing into the material	*Human part* Finger *Human made* objects lids-wood, plastic	Exploring an unknown material	Force, properties of material
Exploring material	2. Pulling at edge of material	fingers	Experience of properties	Properties
Changing- control over material	3 Making shapes pushing in shape cutters	Use of an available tool Shapes with outline and hollow middle e.g. biscuit cutter, bottle tops,	Experimenting with tools available, indicates some understanding of the properties of the material	Push, understanding property of material
Making something Using previous knowledge	4 Pulling off small lumps	Hands pull and twisting pieces off and rolling into spheres, small ball's.	Using previous experiential knowledge to fulfil child's planned objective	Forces, pieces of material, knowledge of properties

Table 2. The play cycle analysed for the playdough interaction of toddler Jack

Play Cycle stage	Action of child (12 months)
Notices item - interest 'caught'	As soon in the hall was put by table by his mother. Pulled himself up and edges along the table edge to the playdough
Observes	Looked,
Explores. What does it do? What can I do? What can I use?	Touched with one finger, held onto table with other hand.
Actions. What happens?	Put hand on it. Was soft. Pressed on playdough with index finger. It sank in
Tries more or loses interest and does something else. Leaves this STEM Play Cycle	Made several holes, very excited Remained in Play Cycle
Repeats actions, changes them.	Made more holes
Remembers, stores for future application.	Lot balance and sat down suddenly on floor.
Communicates to others possibly	Cried (typical communication) and mother rescued him and took him somewhere else. .
Re-enters cycle	He was brought back later on and repeated his actions

The interactions follow a Play Cycle similar to the one that occurs in inquiry science investigation in school. The identification of the stages in the play cycle shown by Table 2 (2) considers the response of Jack, whose first birthday was the next day.

Such analysis can be carried out for all play sequences. Such could be used for recording a child's learning journey, and assessment, if wanted.

8. Discussion and conclusion

Play dough is popular 'piece of equipment' in many early years and pre formal school classes, particularly in play groups and associated gatherings as well as at home if mothers will permit the mess, some do not. The material provided in this particular scenario is easily obtained in countries where the ingredients are available, and other naturally occurring materials may suffice such as clay or mud or dough.

In this particular instance, the material was easily made or bought and a few simple implements such as small rollers plasticise knives, biscuit cutters provided children with instruments which they instinctively used. Perhaps of more importance was the free choice for the child. Although this play reported was not a longitudinal study following the same child [19], the progression in understanding, skills and experiences recalled are apparent

Children play as a first stage in their development and learning journey leading to adulthood. These observations on one activity put out in an informal play group situation where there was free choice, spontaneous play, that is noticing and observing items and then investigating them hands on, shows the progression in 'playing' with a particular substance. Our further observations indicate that this same progression of internet- active inquiry using senses, particularly touch and vision, is replicated in any play situation.

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Best World Practices for Hearing Impaired Learners: the Project Overview

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Abstract. The purpose of a project presented in the paper is to bridge the communication divide between teachers, deaf students and hearing ones in and outside the classroom by building a visually rich learning environment through implementation of advanced technology tools and STEM/hands-on teaching methods. A team of university educators developed and delivered a training program for high school/university students and teachers including workshops, master classes, on-line events. Project results are summed up to determine the project impact.

Keywords. Inclusive Education, Hearing Impairment, STEM, Hands-on Method, Best Practice, Science Teaching, Communication Divide, Technology.

1. Introduction

Implementation of new effective tools and strategies in deaf education is a vital issue in Ukraine where the population with hearing impairment reaches 42 thousand. They can receive secondary and vocational education at special schools. A few universities introduced degree programs for deaf students, though they are enrolled in special groups and have no instructional or extracurricular activities along with fellow students. The Law on Inclusive Education expands opportunities for deaf high school graduates. Increasingly they are electing to go to universities and vocational schools individually or in small groups on general terms. However, communications divide between them and their classmates and teachers remains. It is an additional challenge which deaf students have in or outside the classroom, and they would get through it if they are provided with assistive tools to facilitate efficient communication. No universal method of deaf education exists. The assistance of a sign language interpreter is the traditional form of learning support for deaf students. However mostt students who are deaf are primarily visual learners. That is why communication and instruction with this student population can be enhanced through building a visually rich learning environment using information technology tools and hands-on teaching.

2. Project actiivities

In the framework of the project, a team of university educators from Lviv, Temopil and Khakiv delivered a training program on using hands-on teaching methods in the classroom.

2.1. Off-line events

Four off-line training seminars provided 100 university students, faculty members and high school teachers with new knowledge and skills on using innovative educational tools and techniques for teaching students with hearing impairments. A few examples are below.

Figure 1. Teachers' discussion on visibility problems in deaf education

Students and teachers from Mariya Pokrova Boarding School for the Deaf in Lviv participated in the seminar on visibility problems in deaf education at the Ukrainian Academy of Printing (Fig. 1). They discussed how visual effect of instructional materials can be improved.

Senior students from Krupynsky Medical Academy in Lviv (LMA) carried out a training session on using “Telemedicine” interactive simulatiuon software to study protocols and equipment implemented in telemedicine systems.

Figure 2. Telemedicine simulation

Field practice on visualization tools for LMA students and a guided tour for deaf high school students took place at the Natural History Museum in Lviv (Fig. 3).

Figure 3. Field practice at the Natural History Museum in Lviv

LMA students saw visualization technology in action and filmed several videos. They supplemented these materials with subtitles (Fig. 4) and donated them to the Museum to popularize educational resources created specifically for the hearing impaired visitors.

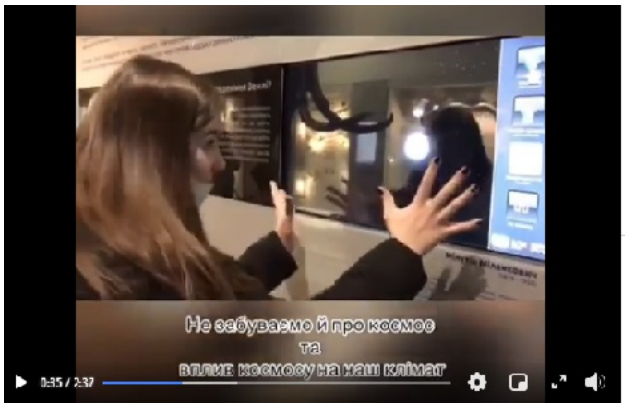

Figure 4. A frame from the subtitled video about the Ice Age

Students and teachers from Mariya Pokrova Boarding School for the Deaf were invited to LMA premises where some of the school graduates study laboratory medicine. They could learn more about this profession which one of career options for hearing impaired people.

2.2. Events organized by faculty members of the National Technical University “Kharkiv Polytechnic Institute” (NTU “KhPI”)

Four off-line STEM hands-on masterclasses for 42 secondary school teachers were conducted at NTU “KhPI”. Outreach events for schoolchildren were carried out at Kharkiv Specialized Secondary School #5 (former regional boarding school for the deaf).

In October, a team of ecologists from NTU “KhPI” held two offline events as part of the project at the #5 School. The first was devoted to studying the content of nitrates in food. All vegetables and fruits are different, what is the norm, and how to measure nitrates with the help of the device? The organizer of the event Tetyana Tykhomyrova gave the opportunity to personally check the apples which pupils grew on their own in the school garden (Fig. 5a).

The second event is a master class on upcycling. Children were shown that garbage is not always garbage (Fig. 5b). Wonderful notebooks were made from the remains of

notebooks, fabrics, ribbons. The level of skills impressed both volunteers (3rd year students of the Department of Chemical Engineering and Industrial Ecology of NTU "KhPI"), and teachers and children. Flight of fantasies - not limited!

a) b)

Figure 5. Ecology practice at the Kharkiv Specialized Secondary School #5 held by a team of ecologists from NTU "KhPI"

Then physicists from NTU "KhPI" also came with the project "Physics is Easy!". They demonstrated interesting experiments on the basic physical phenomena in the format of hands-on science.

2.3. On-line activities

Due to the ongoing COVID-19 quarantine, a number of seminars and discussions were held on-line. Totally, they involved 130 participants from Lviv, Kharkiv, Temopil, and Cherkassy universities and high schools.

Zdenek Drozd and Dana Mandikova (Department of Physics, Charles University) presented hands-on approach in teaching physics and demonstrated experiments in mechanics concerning in particular Newton laws, impulse of force and change of momentum, weightless state and decomposition of forces and also several experiments in electrostatics (electrostatic induction, electrostatic pendulum and motor, electrostatic precipitator of smoke), which require minimum explanation and can be used in education of the deaf in the inclusive education context (Fig. 6).

School/university teachers and university students (future teachers) have learned a new creative approach to how they could teach physics using common items which everybody has in hands and even human body.

Dmytro Vakulenko (Horbachevsky National Medical University in Ternopil) showed how WolframAlpha and Comsol (Fig. 7) software can be used to visualize various tasks while teaching biomedical, pharmaceutical and science courses. A few simulation examples were examined to determine those of them which can be recommended for deaf students due to high level of visual support.

Figure 6. On-line physics demonstration from Charles University

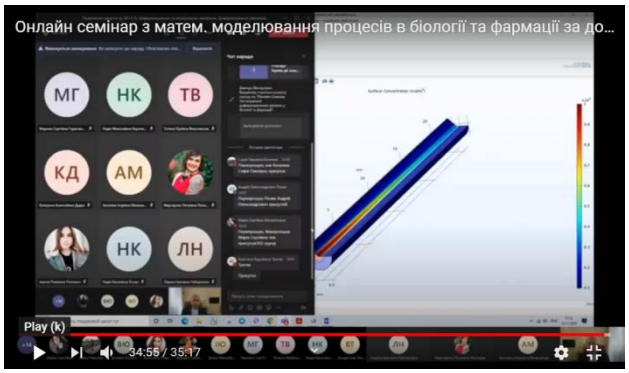

Figure 7. Workshop on biomedical simulation

An on-line master class for high school science teachers was held at the Natural History Museum in Lviv to hightlight educational resources for the deaf, and to provide examples of classes in the Museum.

At the end of January this year, project mentors Dana Mandikova and Zdenek Drozd, Denise Balmer, Serhii Radohuz, Tetiana Tykhomyrova, Olha Andreieva, Kseniia Minakova shared their experiences and, before writing a book of practices, discussed the achievements with students, teachers and educators from more than 70 cities of Ukraine at the XVIII International School-Seminar "Modern pedagogical technologies in education" on the basis of the Methodical Department of NTU "KhPI" (Fig. 8).

Figure 8. XVIII International School-Seminar "Modern pedagogical technologies in education"

Figure 9. Activities and experiments

3. Fair of educational best practices for hearing impaired learners

The Fair took place in Lviv in May 2021 and attracted 54 participants from specialized educational institutions that cater for children with special needs, university faculty members, research fellows, and consultants from the Center for Professional Development of Teachers in Lviv. It became a main event of the project due to interesting practices announced in the Fair program and the format of the event itself. Both students and teachers were involved in various activities and experiments including (Fig. 9):

- open ceremony;
- project presentation;
- physics experiments;
- cheking food for nitrates;
- chemistry experiment;
- simulating telemedicine procedures;
- communicating with a virtual patient;
- travelling back to the Ice Age;
- working with mobile applications to recognize plants;
- decorating gingerbread;
- an interactive session at the Mystery Pharmacy Museum;
- and enjoyed many other things.

LMA students who were members of the organizing committee carried out a quick survey to determine the practices that the participants liked best. Three practices were selected as winners - "STEM project: Physics is Easy", "Maker Approach in Learning Chemistry - Let's Make Together!', "Master Class - the World of Gingerbread". Students of the Vocational School of Trade and Service in Lviv baked prize gingerbread (Fig. 10) as awards for winners.

4. Project publications

The project educational materials, ideas and suggestions of participants are summarized in the “Inclusive Education for Hearing Impaired Learners: Practices of Science Teaching” tutorial [1]. Compiled and published in the frame of the project, the book presents STEM and hands-on practices in teaching physics, chemistry, biology, environmental science and engineering; explains the potential of information technology in deaf education; shows the importance of museums as an informal environment to study science and technology; and provides recommendations on developing research skills, engineering thinking and observation habits in children.

Science and technology education is very important today, because the results of research and development are around us every

day. Critical decisions that affect all aspects of our life are made based on scientific evidence. In fact, teaching science to schoolchildren and students is teaching them how to think, learn, solve problems, and make informed decisions. These skills are integral to education and life. The book aims to develop just such skills.

Figure 10. First place prize gingerbread

The value of experiments and other classroom tasks was confirmed both during the project events with direct involving teachers, schoolchildren and students, and in participants' professional activity. To make the book more easily accessible, it is uploaded in the repository of NTU “KhPI” [2].

5. Project outcomes and feedback

To evaluate the project results and impact, a survey was conducted among the project direct participants. First of all, we wanted to find out their opinion regarding the usefulness of the Fair format for holding educational events; the role of natural and technical sciences in education; a current state of their teaching; introduction of STEM and hands-on approaches in inclusive education; etc. A group of respondees included school teachers, university faculty qualifying future science teachers, staff members of the Center for Professional Development of Teachers. They reported that:

- the Fair format is perfect for educational events, as it allows participants to be active, acquire practical skills and share experiences;
- the priority of science in education is undeniable, but insufficiently recognized;
- the level of science teaching in schools is insufficient, in universities it is not bad, but without a creative approach;
- the implementation of STEM, hands-on approaches will be a significant contribution to improving science teaching within the inclusive model;
- the potential of informal environments such as museums deserves more attention and more complete integration into inclusive education;
- all best practices presented at the Fair are ready for use in educational institutions.

Also the need to continue similar projects and events was highlighted.

6. Conclusions

In conclusion, the project has significant educational value as a tool to implement best world practices of science teaching in inclusive education of hearing impaired learners. Participation of schoolchildren and students with hearing impairment and their teachers in the project events allowed testing the utility of our methods for this, core target audience of the project. Maximum visual support in the classroom has proven to be effective. At the Fair it could often be seen that deaf students did without the help of a sign language interpreter, since it was enough to observe the demonstration of experiments or activities, to understand their essence. The main message of the participants' survey is: hands-on approaches should become a significant

contribution to improving STEM/science teaching in inclusive learning environment.

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Online STEM Practice Example: Pythagoras Cup

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Abstract. The aim of this study is to get the opinions of students about their online studies through the online STEM activity called the Pythagoras Cup. The research group consists of 24 students. The data obtained after the interviews were analyzed by content analysis. According to the results of the analysis, the positive opinions of the students towards the online STEM activity are about finding the lesson enjoyable and interesting, willingness to research, developing the design, cooperation, saving time, building self-confidence and democratic environment. Negative opinions received from students are internet connection problem, inability to interact, difficulty in testing, distraction and lack of time.

Keywords. Pythagoras Cup, STEM, Online Learning.

1. Introduction

The STEM education system is an educational approach that enables students to be successful in STEM fields by helping them digitalize and think technology-based [1]. STEM education aims to enable students to find solutions to the problems they will encounter in daily life and in the future, organize information, transfer the information they have acquired to different disciplines, and produce solutions for problems [2]. Effective online learning should equip learners with instructional content in ways that encourage the selection, organization, integration and transfer of new knowledge. First, the student's attention should be drawn to important information in education. Then the student should integrate the instructive words and images with each other and with their prior knowledge. Finally, new knowledge and skills built in the student's long-term memory should be transferred to work after the educational activity. Effective practice exercises should support all these psychological processes [3]. At the same time, it is stated that online learning can improve learning experiences in the field of STEM and facilitate interdisciplinary education [4]. The aim of this study is to get students' opinions about the "Pythagorean Cup" STEM activity held online.

2. Online STEM Practice Example: 3D Birdhouse Design

2.1. Attainments

- Science: Understands that fluid is transmitted from high pressure to low pressure.
- Maths: Uses units of length measurement.
- Engineering: He designs the solution proposal he thinks about the problem he encounters by drawing it on paper.
- Technology: Selects the most suitable material for the product to be made.

2.2. Problem

Your teacher has assigned you a project about the value of fairness. The project task is: Fruit juice will be distributed to students in the school. You must put the same amount of juice in each student's glass. Even a small amount of extra juice should be emptied from the glass on the grounds that it is not fair. Can you design a glass that takes the same amount of juice and empties all the juice when you try to add too much?

2.3. Aim of the Activity

Students need to learn about liquid pressure and design a glass using liquid pressure and turn it into a product.

2.4. Information on Liquid Pressure

The Pythagorean cup is named after the Greek mathematician Pythagoras who lived 2000 years ago. Pythagoras' glass was designed to catch greedy people trying to get more than their fair share. Pythagoras had taught his students a lesson about moderate consumption that they would perhaps never forget for the rest of their lives. The object, which looks like a glass from the outside, can amaze everyone with its function.

The hole in the column in the middle empties all the liquid inside if the glass continues to be filled after a certain level. The physical rule behind this invention is nothing

different from the working principle of the siphon. After filling the cup a certain amount, gravity will accelerate some of the liquid downwards. Since the pressure of the accelerating liquid will be low, there will be a pressure difference between the visible part of the liquid and the high pressure liquid will push the low pressure liquid. This process will continue until the pressure difference is zero, that is, all the liquid is drained from the cup.

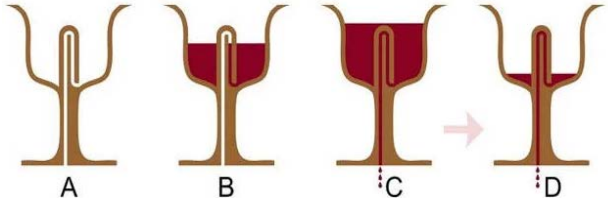

Figure1. Obtained from [5]

2.5. Design

"How can I design glasses that can hold an equal amount of juice and allow the juice to drain completely from glasses with more juice than there should be?" According to the question, the students designed their glasses.

While designing, students clearly thought about how they would achieve their goals by transforming their ideas into drawings. First of all, each student in the group drew their design on the design drawing papers. The points that need attention are determined in the design drawings.

Figure 2. Pythagorean Cup designs

As seen in Figure 2, students drew their designs on A4 paper. They indicated the name of their design, the date and their own names on the paper. When the students finished their design drawings, each student introduced their own design. When the students in the group were asked about the designs, the owner of the design answered the questions.

2.6. Tools

Bendy plastic straw, scissors, bowl of water, plastic cup, plastic bottle, rubber band, adhesive putty, colored tape

2.7. Product Development

The students, who completed the design drawings and explained the details of their designs, moved on to the product development phase with the guidance of the teacher. The teacher shared the materials that may be needed before the lesson in the WhatsApp groups she set up for each group and stated that they should have the materials ready before the lesson. In material selection, attention was paid to the selection of the most suitable and non-hazardous materials. The product development stages are as follows:

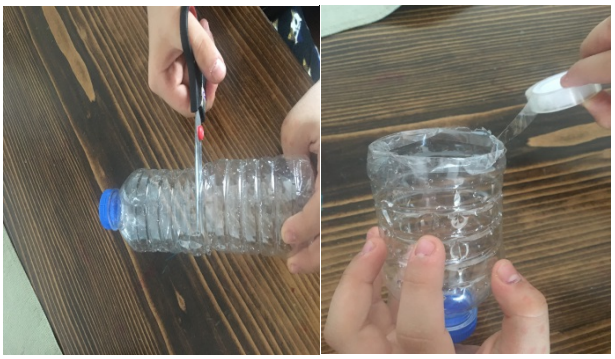

Figure 3. Cut of the bottle

Figure 4. Piercing the cover

Cut the circumference of the bottle approximately 10 cm from the top. Cover any sharp or uneven parts of the cut edge with tape (Fig. 3).

Remove the cap from the bottle and make a hole in it with scissors. Coat the bottom of the lid with dough glue to protect the table (Fig. 4)

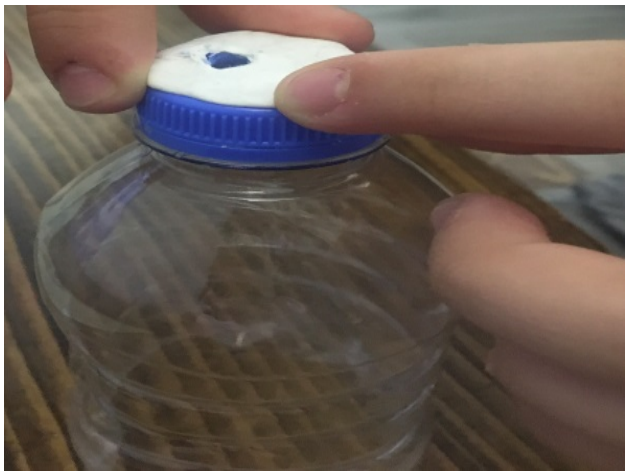

Figure 5. Covering the lid with adhesive paste

Spread the sticky paste piece on top of the lid. With the scissors, drill a hole that lines up with the hole in the cover (Fig. 5)

Figure 6. Folding the straw

Cut about 2 cm from the curved part. Fold the straw at the curved part and secure it by wrapping it with a band (Fig. 6). Punch a hole in the center of the bottom of the plastic cup. Make sure that this hole is the thickness of the straw. Apply adhesive paste to the back of the glass to protect the table (Fig. 7). Pass the long end of the folded straw through the hole in the plastic cup. Make sure the folded part of the straw goes all the way to the bottom of the glass (Fig. 8). Insert the long end of the straw through the hole in the bottle cap with the adhesive paste. The adhesive paste prevents leakage (Fig. 9).

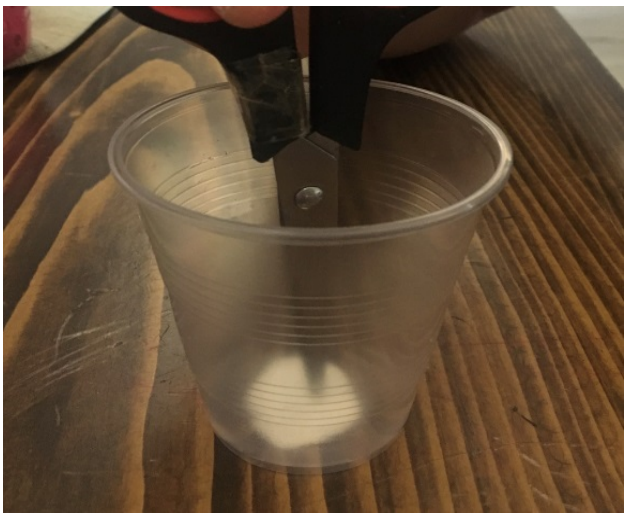

Figure 7. Piercing the glass

Figure 8. Passing the straw through the hole in the glass

Figure 9. Joining the glass and bottle with adhesive paste

2.8. Testing

Students did the testing phase of their products as homework after the lesson. While performing the test, they made their presentations. They explained how they made the product, in which situations they had difficulties or experienced ease. They shared these test stages with video footage and photos in watsapp groups. Test phase examples of the

products (Pythagorean Cup) created by the students are given below.

Figure 10. Examples of the Pythagorean Cup test phase

As you fill the glass, the water is pushed by the pressure of the water and moves up the straw. As the water continues to be poured, the water moves up the straw. When the water level in the glass is higher than the height of the straw, the pressure of the water pushes the water. The water continues to flow because the pressure at the bend in the straw remains lower than the pressure at the open part of the straw inside the glass.

3. Findings

3.1. Student Opinions

According to the opinions received from the students, the positive opinions of the online STEM activity are finding the lesson enjoyable, finding the lesson interesting, willingness to research, developing the design, cooperation, saving time, teaching in a comfortable environment, building self-confidence and democratic environment. Negative opinions received from students are internet connection problem, inability to interact, difficulty in testing, distraction, boredom and lack of time.

Table 1. Online STEM (Pisagor Kupası) Activity Student Opinions

Themes	Categories	N	%
Positive reviews	Willingness to research	12	7,8
	Cooperation	11	7,2
	Design development	12	7,8
	Ease	7	4,5
	Build self-confidence	8	5,2
	Teaching in a relaxed atmosphere	9	5,8
	Saving on time	12	7,8
	Effective learning	10	6,5
	Finding the lesson interesting	13	8,5
	Willingness to learn	11	7,2
	Finding the lesson enjoyable	14	9
	Democratic environment	7	4,5
Negative reviews	Distractibility	4	2,6
	Inability to interact	5	3,2
	Internet connection problem	9	5,8
	Boredom	2	1,3
	Difficulty in testing	5	3,2
	Lack of time	3	1,3
Total		154	100

4. Results

The Pythagorean Cup event is not a unique event. Many teachers perform this activity. The aim of this study is to get students' opinions about the Pythagorean Cup STEM activity held online. These views are intended to support the literature in the planning and realization of online STEM activities.

The Pythagorean activity, which was carried out in accordance with online teaching, was applied to 4 groups separately. Before the lesson, a watsapp group for each group was created in the watsapp application. In the course, the steps of problem identification, research, brainstorming and product development from the engineering processes were done online in the course. The test phase

was given as homework after the lesson. As a criterion for the test phase, the entire water in the glass must be emptied. Students shared this test phase as a video image in the WhatsApp student group. In the shared images, the students also made presentations about their products. For the test images, the group members expressed their opinions about each other's work. After the activity, which lasted for 2 lesson hours, the written opinions of the students were collected. Written opinions received were analyzed with the computer package program (Atlas.ti8). In the analysis, two themes were determined, namely positive opinions and negative opinions about online STEM activity. Categories for these themes were created. Analysis results are given in Table 1.

According to the positive reviews about the online Pythagorean Cup STEM activity finding the lesson enjoyable and finding the lesson interesting are the categories that receive the most views. Time saving, willingness to research, willingness to develop design and course, and cooperation received a high number of opinions. According to these views, in the online STEM activity we can say that students are attracted to the lesson, their desire for the lesson increases, effective learning takes place and they apply cooperation effectively. At the same time, the students stated that it became easier to do research on the Internet in the online environment and this saved time. The fact that each student presents their design in the lesson and that the students are given equal opportunity to speak can be seen as the reason for expressing the democratic environment view. As the reason for stating the self-confidence increase opinion, it can be stated that students feel more comfortable behind the screen and express their thoughts more easily.

Students' negative opinions about online STEM activity have been distraction, difficulty in the design phase, inability to interact, lack of time and boredom.The most internet connection problem was determined as negative opinion. Some of the students were not able to attend the class on time and they had a slight internet connection problem. Sharing the video footage of the test phase in the group and the inability to interact with the group friends face-to-face were stated as negative opinions, albeit few in number.

According to the students' opinions in the study, it can be said that the online application of the STEM Pythagorean Cup event is seen as effective and positive by the students.

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Textual Understanding of Original Research Articles by Undergraduate Chemistry Students

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Abstract. This paper aims to investigate the understanding of original research articles on the topic of biofuel, taken from the Química Nova journal, by undergraduate chemistry students, in the context of a scientific communication course. To this end, retextualization carried out by groups of students of an original research article for a corresponding oral presentation was analyzed. The results indicated that there was no comprehension of the totality of the original research articles by the students, however, in some moments, retextualization operations were used that indicated considerable understanding of them.

Keywords. Chemistry Education. Oral Presentation. Original Research Article. Textual Understanding.

1. Introduction

Learning in science education occurs predominantly through scientific language, which has several functions, including clarifying ideas, inferring, comparing, observing, predicting, and differentiating. Thus, their domain substantially contributes to quality scientific education, and this can be achieved, for example, from reading and interpreting scientific texts. Reading and understanding original research articles by undergraduate chemistry students provides greater capacity in developing criticisms and establishing relations between scientific contents [1-2]. Despite being such a relevant skill, research on the subject is scarce, especially in Brazil.

In this perspective, this paper aims to investigate the understanding of original research articles on the topic of biofuel, taken from the *Química Nova* journal, by undergraduate chemistry students. To this end, retextualization carried out by three groups of students (G1, G2 and G3) of an original research article for a corresponding oral presentation was analyzed, and then relations between this process and textual understanding were established. The investigation was based on studies on retextualization operations and horizons of textual comprehension, proposed by Marcuschi [3-4].

For the analysis, the following retextualization operations were considered: content addition; deleting a word, expression, image or punctuation mark; topical reordering, changing the order of information from the original text; word, expression, image, or punctuation mark replacement; condensation of information; paraphrase, rewriting a part of the base text from a linguistic form to an analogous one; resumption of statements [3].

The textual comprehension horizons [4], which demonstrate the levels of understanding of the original research articles by the students in the preparation of slides for the oral presentation, were also considered in the analysis, namely: lack of horizon (the reader repeats information given in the text); minimum horizon (reader paraphrases information after selecting it, adding and replacing words); maximum horizon (reader performs inference activities, reading between the lines, grouping various information in the text, adding new information and knowledge related to them); problematic horizon (reader inserts personal knowledge into the information given in the text and understands beyond the limit of such information; undue horizon (reader misunderstands the ideas contained in the text).

The steps of the didactic sequence that led to data collection for analysis are described in the following topic.

2. Didactic sequence to promote textual understanding of original research articles

The didactic sequence was applied in a scientific communication course, offered to undergraduate chemistry students at the University of São Paulo, Brazil. The class consisted of 30 students, who performed most of their activities, divided into five groups with four members each and two with five members

each. To carry out the activities of making the oral presentation, an original research article was given to each group of students (Table 1).

Tabel 1. Original research articles selected for reading by undergraduate chemistry students

	AOP
G1	Physico-chemical characterization of oily sanitary waste and of oils and greases extracted for conversion into biofuels. **Química Nova**, 37(4), 597-602, 2014.
G2	Transesterification of vegetable oils: characterization by thin-layer cromatography and density. **Química Nova**, 30(8), 2016-2019, 2007.
G3	Characterization of solid residue formed in beef tallow biodiesel bo bovino. **Química Nova**, 35(10), 1901-1906, 2012.

The original research articles address the biodiesel theme, which is current and has a content that is commonly discussed in chemistry classes.

Table 2. Stages of didactic sequence applied in the scientific communication course

Presentation of the situation	Review activities on the characteristics of the original research articles and instruction on the characteristics of the oral presentation.
Initial production	Oral presentation preview of the original research articles and comments from the lecturer.
Intermediate modules	Discussion of the structural and rhetorical characteristics of the original research articles.
Final production	Final oral presentation of the original research articles.

The didactic sequence, based on the retextualization of the original research articles for the oral presentation, was carried out based on the model by Dolz, Noverraz and Schneuwly [5] (Table 2). According to the authors, a didactic sequence is “a set of school activities systematically organized around an oral or written genre” (p. 97) [5]. In this context, it favors students' mastery of genres and communication situations. Each of the steps described in Table 2 is detailed below.

2.1. Presentation of the situation

Each group of students received an original research article. After that, students were asked to carry out three individual activities, in extra-class time, to promote a better understanding of the studied article.

The first activity consisted of reading part of the article and solving questions concerning the topics Abstract, Introduction and Experimental Part. This addressed the objectives of the publication, requested the creation of a glossary with terms unknown by the students and preparing a flowchart elucidating the Experimental Part, as well as a summary of the analytical techniques used by the authors.

The second activity followed the precepts of the first, focusing on the topic Results and Discussion. In addition to the glossary, the specifications of the images and tables of the articles, questions about the scope of the proposed objectives and the indication of the realization of future work were addressed.

The third activity gathered questions about the general view of the article and its bibliographic references. Aspects related to the arguments used by the authors to defend the proposed solution to the research question investigated in the article and the classification of references in academic works, original research articles, books etc. were addressed.

2.2. Initial production

This step consisted of delimiting the preparation of a previous oral presentation about the content of the original research article by the students, in a simplified way, focusing on the Introduction and Experimental Part, with an estimated duration of ten minutes, using slides prepared in presentation editors as support material, such as PowerPoint™ (Figure 1). The objective of the oral presentation was to introduce the theme (biodiesel) and elucidate the experimental techniques and procedures involved in the studied original research article, which could be unknown to colleagues. In this context, the lecturer in charge can define at which moments their intervention would be necessary to help students find the desired didactic objectives [6].

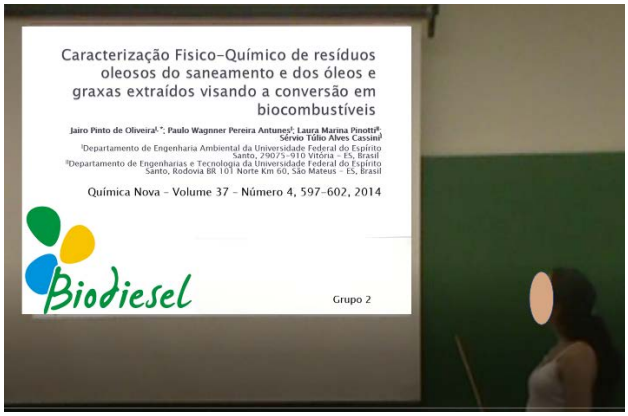

Figure 1. Student presenter from G1 during the oral presentation (inicial production stage)

2.3. Development of rhetorical activities: intermediate modules

From the activities presented in the article by Oliveira and Queiroz [1], the lecturer used five of them sequentially, once a week, namely:

- Activity 1 - Review of sections of scientific texts (Introduction, Experimental Part, Results and Discussion, Conclusions and Bibliography).
- Atividade 2 - Activity 2 - The allies of scientific texts: they can be internal and external, for example, citations from credible journals in the area; citations from renowned authors; the appointment of funding institutions; and citations of works by other authors who have researched the same topic.
- Activity 3 - The presence of the author in scientific texts: evidence of the author's presence is identified when they justify carrying out the research reported in the original research articles, give opinions on the results obtained during the research, make evaluations about the investigation itself, indicate the need for future work, formulate hypotheses).
- Activity 4 - The types of citations in scientific texts.
- Activity 5 - Working with citations in scientific texts: some strategies used include citing other documents that agree with the idea proposed by the author and using references that show contrary ideas.

2.4 Final Production

This step started by preparing the oral presentation based on the full content of the original research article, with an estimated duration of 15-20 minutes, using slides produced in presentation editors as support material, such as PowerPoint™ (Figure 2). At the end of each presentation, the students asked questions about the oral presentation and these were answered by the members of the presenter's group and by the presenter. This production was required in order for the student to put into practice what was learned in the previous activities and enable the lecturer's assessment of their evolution in relation to the initial production [6].

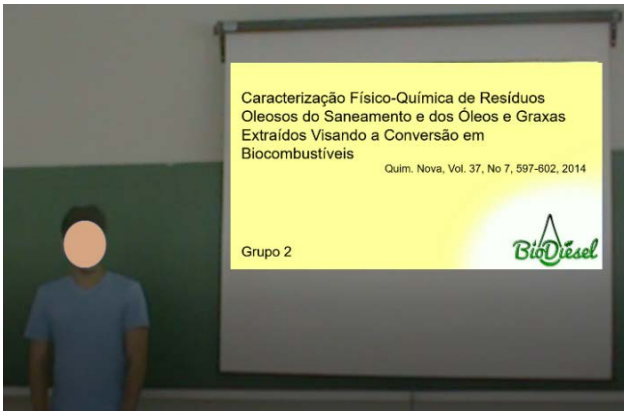

Figure 2. Student presenter from G1 during the oral presentation (final production stage)

From the activities described, the groups of students produced different numbers of slides in the oral presentation of the final production stage, namely, 14 (G1), 18 (G2) and 15 (G3), and presented different levels of textual comprehension, from copying information from the original research article, to making inferences and adding new information from interpreting it.

It was found that the groups used all the retextualization operations reported in this paper on the slides, as well as showing all horizons of textual comprehension. Thus, different types of operations, having different purposes, as well as understandings in the most varied degrees of complexity were used.

Considering this, it was found that textual understanding in the minimum horizon was the most recurrent on the slides of the three groups, a fact that is possibly associated with the students' fear of making mistakes. Textual

comprehension in the maximum horizon was also one of the most recurrent, showing the performance of activities of a high cognitive level.

3. Conclusion

As a result, it can be concluded that making the slides that comprise the oral presentation mostly occurred without affecting the communicative purpose established by the authors of the articles. In addition, the work contributes to the expansion of studies that provide theoretical and methodological support that can reshape teaching-learning activities developed in undergraduate chemistry courses, aiming to foster skills related to reading and understanding original research articles.

4. Acknowledgements

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Modelling a NETmix Reactor for Mixing and Chemical Reaction

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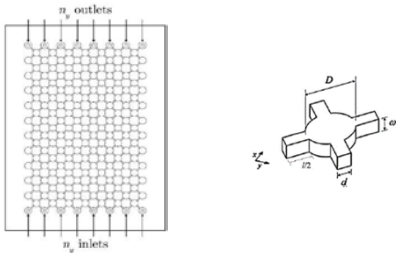
Abstract. NETmix Reactor is a novel mixer and chemical reactor consisting of a network of mixing chambers connected by channels. The network is generated by the repetition of unit cells. Each cell has a cylindrical chamber and two inlets, and two outlets oriented at a 45º angle from the main flow direction. This reactor can be applied in many areas of chemical engineering, namely the production of chemicals and water treatment. The main goal of this work was the development of a CFD (Computational Fluid Dynamics) model that could predict the performance of a unit-cell of the NETmix Reactor. For that purpose, 2D CFD simulations were performed to assess the flow field and chemical reaction inside the cell. This project was developed by 12th grade chemical students in collaboration with the Department of Chemical Engineering of the Faculty of Engineering of the University of Porto.

Keywords. NETmix Reactor, Computational Fluid Dynamics, Residence Time Distribution, Chemical Reaction.

1. Introduction

The NETmix reactor is a novel mixing technology and chemical reactor, which consists on a 2D network of mixing chambers interconnected by transport channels. The network (Fig. 1a) is generated by the repetition of unit cells where each unit cell consists of a cylindrical chamber and rectangular cross-section area channel (2D unit cell, Fig. 1b) [1]. NETmix Reactor is already applied in several areas of chemical engineering, namely to produce hydroxyapatite [2] and microcapsules with antioxidant and antimicrobial active principles [3], for the continuous production of CO2 hydrates [4] and photocatalytic water treatments [5].



(a) (b)

Figure 1. (a) Scheme of a NETmix network: (b) 2D unit cell

2. Materials and Methods

2.1. NETmix Cell Design

The NETmix unit cell was designed in Ansys Design Modeler. This cell is composed of a circle and four rectangles oriented at a 45º angle from the main flow direction. The characteristic dimensions of the designed cell are summarized in Table 1.

Table 1. Dimensions used in the cell design [1]

Geometric Parameter	Dimension
Chamber diameter, D (mm)	6.5
Channels dimension, d (mm)	1
Geometry depth, ω (mm)	3
Channel length, l^0 (mm)	2

2.2. Computational Grid

After carrying out the cell design, three different meshes were analysed to evaluate the mesh-dependence of the results. The properties of the three meshes are shown in Table 2.

Table 2. Number and size elements of the three mesh

Mesh_1	
# of elements	4390
Element Size (mm)	0.1
Mesh_2	
# of elements	16663
Element Size (mm)	0.05
Mesh_3	
# of elements	45771
Element Size (mm)	0.03

2.3. Hydrodynamic Simulations

2.3.1. Steady-State Simulations

At first, the flow simulations were performed at steady-state regime using a laminar flow regime with water as fluid. The velocity of water at the inlet was calculated from the Reynolds

number formula (Equation 1), considering the properties of water at 20 ºC.

$$\mathrm{Re} = \frac{\rho v d}{\mu} \quad (1)$$

where ρ is the fluid density (kg m^{-3}), v is the fluid velocity (m s^{-1}), d is the characteristic dimension of the flow (m), and μ is the fluid viscosity (Pa·s).

Three simulations were carried out using different Re number, thus, three different inlet velocities. Table 3 presents the boundary condition at the inlets.

Table 3. Inlet conditions

# simulation	Re	v_{in} (m s^{-1})
1	150	0.15
2	200	0.20
3	250	0.25

2.3.2. Dynamic Simulations (RTD)

Residence time distribution (DTR) was determined using a transient state simulation of a tracer injection experiment. Starting from the stationary velocity field, the tracer concentration at the input was changed at the initial time from 0 to 1 and the system response to the perturbation was monitored by dynamically recording the tracer concentration at the outlets. For that purpose, the *Species Transport* model was selected, and a tracer with identical properties of the working fluid was defined. It was assumed a diffusivity of the mixture of 10^{-9} m^{2}s^{-1}. In order to obtain the best results, some parameters of dynamic simulations were determined:

Space Time $$\tau = \frac{V}{Q_{in}} \quad (2)$$

Time Step Size $$\Delta t = \frac{\Delta x}{v_{in}} \quad (3)$$

where V is the volume of the NETmix cell (m^3), Q_{in} is the inlet volumetric flow (m^3 s^{-1}), Δx is the size of the elements of the computational grid (m) and v_{in} the average velocity of the inlet fluid (m s^{-1}). From this calculations, the number of time steps was obtained.

2.4. Chemical Reaction Simulation

A chemical reaction is a process in which one or more substances, the reactants, are converted to one or more different substances, the products. The chemical reaction presented in Equation 4 were simulated in steady state, assuming a constant rate (k) of 10^6 m^3 mol^{-1} s^{-1}.

$$A + B \rightarrow C \quad (4)$$

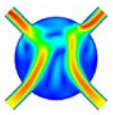
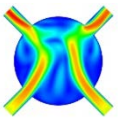
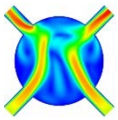
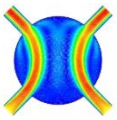
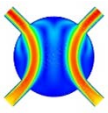
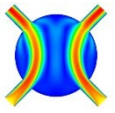
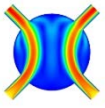
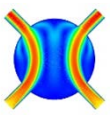
Where A and B are reactants, B is the limiting reactant and C is the product.

3. Results and Discussion

3.1. Computational Grid Dependence

In order to compare the three meshes, the maximum velocity and velocity fields of all the cases were evaluated. In Table 4. the velocity field and maximum velocity for each case were assessed.

Table 4. Mesh Analysis Results

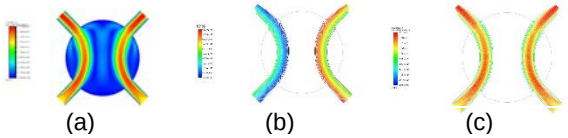
Re	150	200	250
Mesh 1			
Velocity Map			
Max velocity (ms^{-1})	2.34×10^{-1}	3.05×10^{-1}	3.87×10^{-1}
Mesh 2			
Velocity Map			
Max velocity (ms^{-1})	2.15×10^{-1}	2.83×10^{-1}	3.51×10^{-1}
Mesh 3			
Velocity Map			
Max velocity (ms^{-1})	2.16×10^{-1}	2.84×10^{-1}	3.51×10^{-1}

After analysing each mesh, mesh 3 was selected to perform the following simulations because it is more refined thus the results were more reliable. Also, the Re 150 were chosen to perform RTD and chemical reaction simulations.

3.2. Stationary Hydrodynamic Simu-lation

The flow field was evaluated by velocity map and pathlines/streamlines. The fluid does not mix for these conditions, as the figures shown,

the fluid at each inlet follows a jet to the outlet.



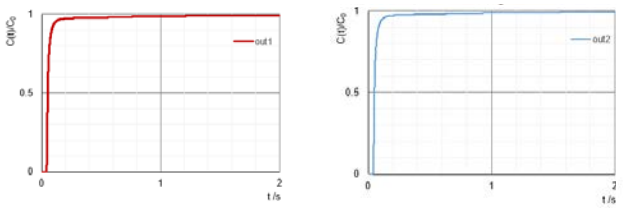
(a) (b) (c)

Figure 3. (a) Velocity Map, (b) ID Pathlines and (c) Velocity Pathlines for Mesh 3 (Re 150)

3.3. DTR Simulation

For DTR simulations, a time step size of $2x10^{-4}$s was selected to perform 5000 times steps, which corresponds to 6τ. In this simulation, the concentration vs time graphic for each outlet was obtained and analysed (Fig. 4).

The concentration varies equally over time for both outlets. At first there is a sharp increase in concentration, which quickly becomes constant.



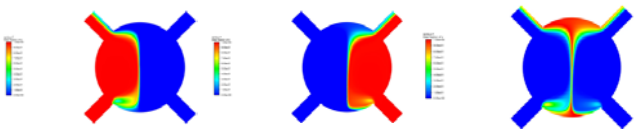
(a) **(b)**

Figure 4. Variation of concentration over time during the simulation in (a) outlet 1 and (b) outlet 2

3.4. Chemical Reaction Simulation

The chemical reaction results were evaluated by the maps of reactants and product concentration (Fig. 5) and the map of chemical reaction rate (Fig. 6).

The coloured region in Fig. 6 represents the local where reagents are contacted, which is where the chemical reaction occurs.



(a) **(b)** **(c)**

Figure 5. Concentration of the reactant (a) A and (b) B and the (c) product C

Figure 6. Chemical Reaction Rate Results

4. Conclusion

In this work, some concepts related to hydrodynamics and chemical reaction were explored. Also, CFD analysis of a NETmix unit-cell were carried out to understand the operation of a NETmix reactor and conclude its efficiency in mixing fluids and in chemical reaction. From our results, steady-state flows present a poor mixing capacity, leading to a bad performance in chemical reactions.

5. Acknowdlegments

This work was financially supported by Base Funding - UIDB/50020/2020 of the Associate Laboratory LSRE-LCM - funded by national funds through FCT/MCTES (PIDDAC). I. S. O. Barbosa acknowledges her FCT scholarship UI/BD/151092/2021.

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APPS 4 SCHOOL. A Citizenship and Development Project with VET Students

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Abstract. Students in the 10th form of the Vocational Education and Training (VET) course in Technical Management and Programming of Computer Systems (TGPSI) intend to develop Apps that may improve the quality of life of students at their school, following the technological education program APPS FOR GOOD.

Keywords. Digital Competences, Citizenship and Development, Quality Education, Vocational Education.

1. Introduction

According to the report Eurydice Education for Citizenship in Schools in Europa – 2017 the citizenship education should contribute to the whole development of students as well informed, responsible and active citizens. Students need to be capable of thinking critically for themselves and harnessed with the knowledge, values and skills that will enable them to interact in a socially, responsable and democratically manner [1]. Within the scope of the Citizenship and Development project, students in the 10th form of the VET course in TGPSI, from Maia Secondary School, developed a project that aims to create Apps, to improve the lives of the students at the school they attend.

2. Methodology and results

The teaching-learning methodology used follow the technological educational program APPS for GOOD, that encourage students to think about the world around, become active and aware citizens, by trying to solve the problems that they find, contributing to a better world. Students identify problems in their community - based on the 17 Sustainable Development Goals - and find digital solutions [2].

Initially, the following challenge was posed to the students: “What kind of applications for smartphones or tablets would you like to develop, that would allow you to solve the problems that exist in our school?”. In groups of 3 to 4 elements and after defining the role to be played by each one (the creator of ideas, the organizer, the designer, the technology specialist, the entrepreneur and the communicator), the students carried out research on: what is an application? (definition / types; platforms / tools) and about the life stories of product creators in the technology industry.

After brainstorming potential ideas for the applications to be developed and brainwriting to expand the initial ideas, the students agreed to develop the following APPS: School First (collection of information / materials on the subjects of Mathematics, Physics, Chemistry and Science), EducApp (learning English, Spanish, German, French), Lost & Found (helping students / teachers to find the lost objects with just a “touch”), Brain Star (exercising the mind and body through virtual activities), Know your school (guiding and knowing the history of Portuguese schools through QR Code), School Finder (guiding new students / students of the projects Erasmus by Escola Secundária da Maia (Application in the following languages: Portuguese, Spanish, English and French), MLibrary (request books from any Library), Library 4 Everyone (literary recommendations).

To estimate how many students, from Maia Higher School, might potentially be interested in the new products, a questionnaire was applied to these students about the usefulness of the Apps. Some examples of the questions asked were:

- Do you consider that reading is fundamental to improve your academic path? (Fig. 1)
- Do you think it would be useful to order books online via mobile phone? (Fig. 2)
- Have you ever had difficulty in finding certain places in your school? (Fig. 3)
- If you had an application that would allow you to consult information on the subjects of mathematics, physics, chemistry and science would you use it free of charge? (Fig. 4)

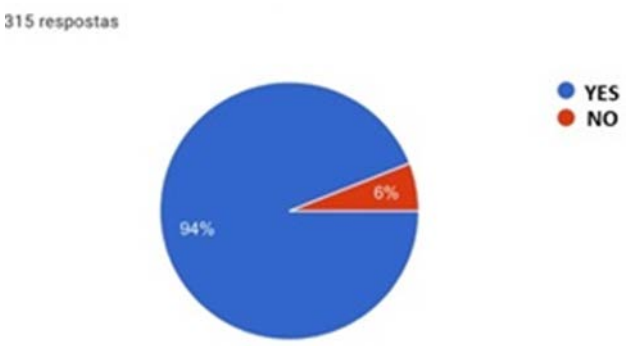

Figure 1. Do you consider that reading is fundamental to improve your academic path? (Yes – 94%, No – 6%)

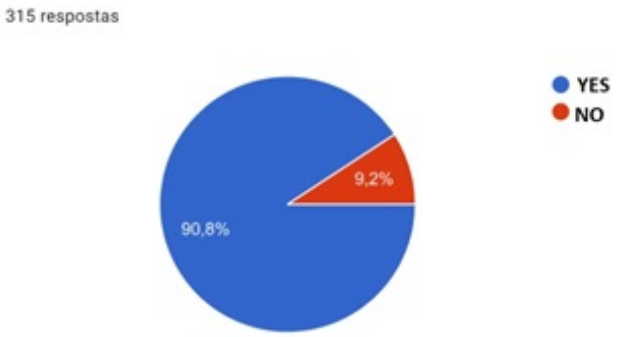

Figure 2. Question: Do you think it would be useful to order books online via mobile phone? (Yes – 90,8%, No – 9,2%)

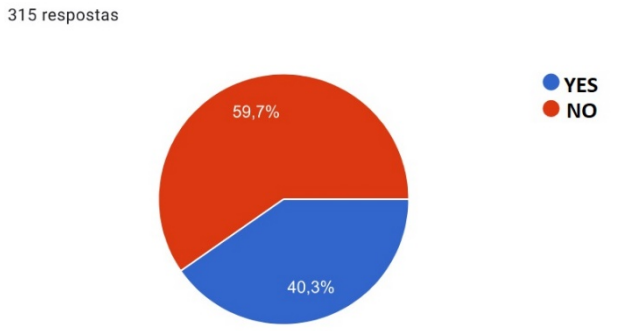

Figure 3. Question: Have you ever had difficulty in finding certain places in your school? (Yes – 59,7%, No – 40,3%)

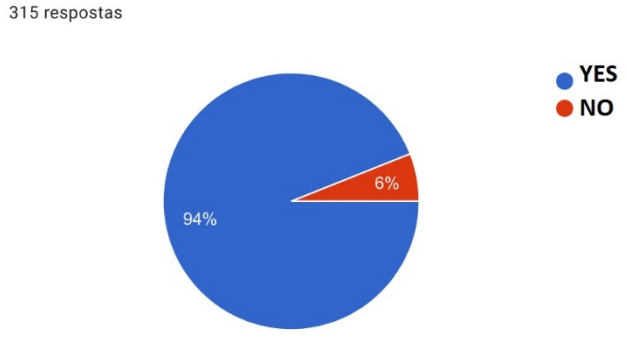

Figure 4. If you had an application that would allow you to consult information on the subjects of mathematics, physics, chemistry and science would you use it free of charge? (Yes – 94%, No – 6%)

From the universe of 315 students, that answer the questionaire, 90% was very enthusiastic about the possibility of having School First, Know your school, School Finder, EducApp, MLibrary, Library 4 Everyone, Lost & Found and Brain Star applications at their disposal.

Next, students moved to the stage of designing the visual aspect of the application, using rapid prototyping tools in order to recreate an existing application, such as Balsamiq and Lucidchart, with which they performed the following: Task 1 - Creation of a screen of login (Login Screen) and Task 2 - Build a second screen and connect the two screens together. The creation of applications is done without the need for programming, using the tools of building blocks.

Using Adalo, a no-code platform for building mobile apps, students start building their prototype (Fig. 5 and 6).

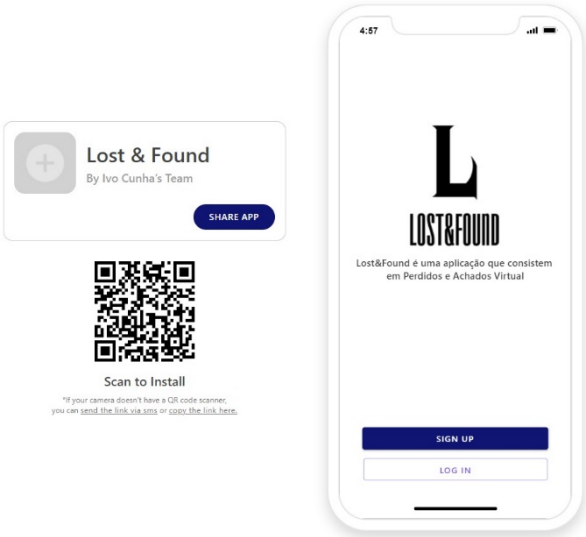

Figure 5. Prototype App – Lost & Found. Work done by the students: Dinis Teixeira, Diogo Teixeira and Ivo Cunha

After understanding the range of different business models available and how to generate revenue from their app, students developed their own business model. They all decided that their apps were going to be free and with adverts (Facebook, YouTube).

Finally, students create a marketing campaign. To summarise the key points of their apps in a short presentation, they create a pitch (Figure 7 and 8) and a poster (Fig. 8 and 9).

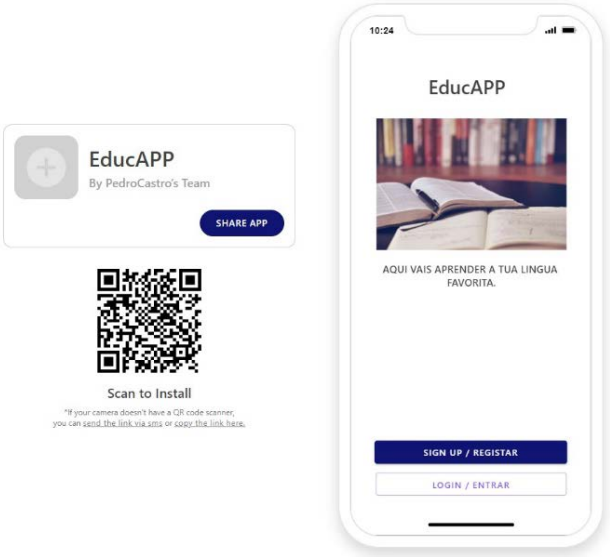

Figure 6. Prototype App – EducAPP.
Work done by the students: Nuno Maia, Nuno Vale, Pedro Castro and Tiago Rego

Figure 7. Pitch – Lost & Found.
Work done by the students: Dinis Teixeira, Diogo Teixeira and Ivo Cunha

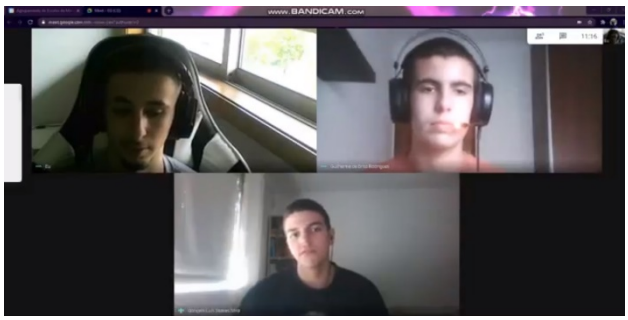

Figure 8. Pitch - MLibrary.
Work done by the students: Afonso Jerónimo, Nuno Teixeira, Rodrigo Rodrigues and Tomás Querido

Figure 8. Poster – Know Your School.
Work done by the students: David Luís, João Rodrigues, João Sousa, Júlio Sousa and Leonardo Silva

Figure 9. Poster – Lost & Found.
Work done by the students: Dinis Teixeira, Diogo Teixeira and Ivo Cunha

3. Conclusions

The activities developed allowed students to reflect on problems, needs or potential for improvement in the school experience, in their organization, in the inclusion and responsible participation of all students, resorting to mobile phone applications. The students developed skills of autonomy, leadership, curiosity, initiative, creativity, adaptability and social and global sense.

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Photovoltaic Solar Energy. A Pedagogic Approach

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Abstract. The present work reports on a simple pedagogic exploration of a photovoltaic solar kit which aims to demonstrate the operation of a mobile orientable photovoltaic solar energy collection system employing a robot built with Lego parts.

Portugal is one of the European countries with the most favorable conditions for solar energy arnessing. It is therefore important to raise awareness and explain to young people across the country how photovoltaic panels work and the different and best ways to use them.

Although in Portugal the production of energy through photovoltaic systems is still relatively low, there is a strong growth potential also by the decreasing purchase prices, namely of silicon photovoltaic panels both polycrystalline and monocrystalline.

The need arises to include in the education of Portuguese students different aspects related to renewable energy. The use and exploration of the activity herein reported aims to contribute to this effort by making young students aware of how photovoltaic solar systems work.

With this demonstration students will explore how and how much electricity is produced by a photovoltaic solar panel and its dependence on the panel orientation the season and time of the day. We expect this type of activity to awaken in young people the interest and curiosity in the area of renewable energies so that in the future they can use, promote the use and contribute to the development of renewable energies and to our world's sustainable development.

Keywords. Solar Energy, Photovoltaic, Robotics.

1. Introduction

Fossil fuels are still unfortunately being used extensively for the most varied forms of generating energy [1]. However, as fossil fuels are exhaustible and very polluting there was a pressing need to create new, cleaner and preferently inexhaustible forms of energy production [1-4]. With this need, the so-called clean energies emerged, such as solar, wind, hydroelectric, among others [2].

Renewable energies have an increasingly important weight in energy production around the world. The sun, and solar energy, is one of the main sources of renewable energy that has seen a great growth in electricity production over the past few decades. Since solar energy is a natural and inexhaustible source it is one of the best existing energy alternatives. Photovoltaic solar energy [5] appears as a valuable alternative in the production of electrical energy through the use of photovoltaic panels that convert solar energy into electrical energy [6]. In recent years photovoltaic (PV) solar panels are being installed at an increasing pace worldwide. On figure 1 it is shown the evolution of the cumulative photovoltaic solar installed capacity in the world on last 20 years and the forecast until year 2050 [7].

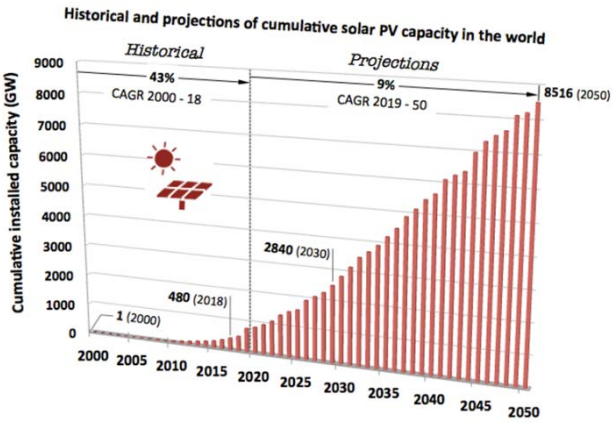

Figure 1. Historical values and future projections of cumulative installed solar PV capacity worldwide [1]

Photovoltaic solar energy brings several advantages, such as:

- It is an energy that does not pollute during its exploration;
- Solar radiation is abundant and free;
- Production plants require little maintenance;
- Panel technology is increasingly advanced, being increasingly efficient and more affordable;
- Solar energy is a good solution for places where there is no electricity grid.

However, using solar energy also has some disadvantages such as:

- Energy production is highly dependent on the meteorological situation;
- During the night there is no production which leads to the need of acquisition of energy storage means;
- In winter, many countries suffer from sudden drops in energy production;
- The forms of solar energy storage are inefficient when compared to other energies.

In Portugal the sun shines all year around for several hours each day. The average number of effective hours of sun in Portugal is of 7.2h. Of course, this number changes along the year been higher in the south of the country. However, the conditions are very good throughout the country and year in Portugal [8] (Fig. 2).

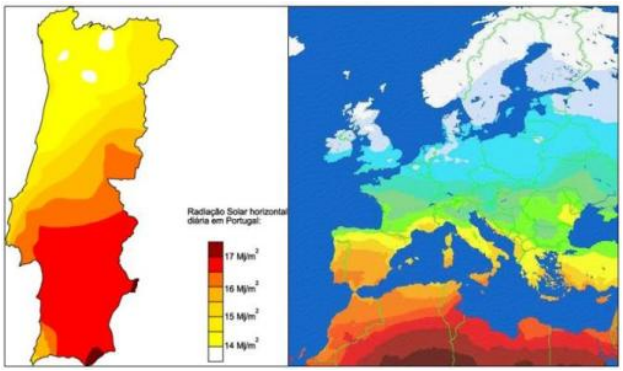

Figure 2. Average daily solar radiation in Portugal (NOCTULA, *Consultores em Ambiente*) [8]

2. Educational robotics

Educational robotics can be characterized by being an educational system that makes students to develop various skills in different areas through hands-on challenges [9].

This method can be considered a meaningful pedagogical tool, since a large majority of the students tend to more easily engage with the execution of experiments, thus actively processing information.

Practical experimental activities have long been one of the most effective ways to lead students to a successful science and technology learning [10-11].

Educational robotics has a multidisciplinary nature, which enables the development and implementation of a new technological culture, at the different levels of education, developing students' creativity through hands-on experimentation. Students can create and develop various types of robots that allow them to solve different problems and create multidisciplinary projects, thus highlighting one of the main objectives of tducational robotics[12] which is the creation of active learning environments based on student committed enrollment. It can be seen as a comprehensive tool, which can be used at different levels of education and as a way to address different content and which can be integrated into teaching from a constructivist perspective.

According to Antonio Valerio Netto [11], the main pedagogical advantages of robotics are:

- Develop reasoning and logic in the construction of algorithms and programs for controlling mechanisms;
- Favor interdisciplinarity, promoting the integration of concepts from areas such as: mathematics, physics, electricity, electronics and mechanics;
- Allow testing on physical equipment what they have learned using in theory or in “model” programs that simulate the real world;
- Transform learning into something positive, making the principles of Science and Technology very accessible to students;
- Encourage reading, exploration and research;
- Prepare students for group work;
- Encourage the habit of organized work, as it develops aspects related to the planning, execution and final evaluation of projects;
- Helping to overcome communication limitations, making students verbalize their knowledge and experiences and develop their ability to argue and counter-argue;
- Develop concentration, discipline, responsibility, persistence and perseverance;
- Stimulate creativity, both when implementing ideas and during the process of solving problems;

- Make the student aware of science in their daily life;
- Develop self-sufficiency in seeking and obtaining knowledge;
- Generate skills to investigate and solve real problems.

3. Robotics and solar energy

The use of robots and robotics to introduce solar energy in educational contexts is not new [10].

In this work an activitiy involving the use of components of LEGO [12-15] robotics kits is used to measure the amount of electrical energy produced by a PV solar panel depending on its orientation.

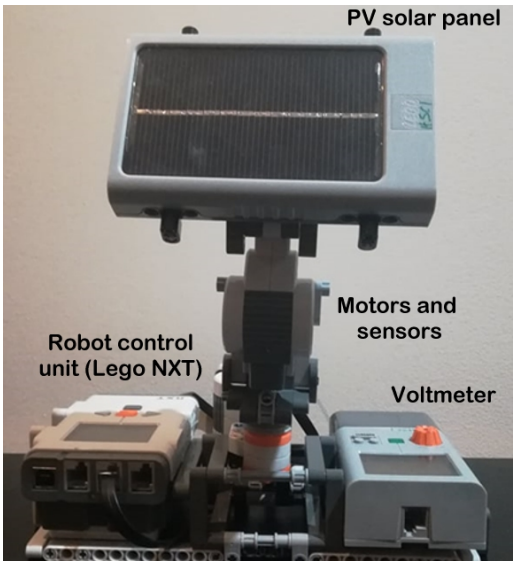

Figure 3. Robot controlled orientable photovoltaic prototype

It is well known that the amount of solar energy reaching the surface of the earth depends on many different factors including altitude and latitude. As well the number of hours of day light also changes along the year. In Portugal the number of hours of effective daylight varies roughly from slightly below 5 in December and January to well above 10 hours in June and July. The direction of illumination of sun light also depends on the hour of the day and on the location. Students know that by personal previous experience and can easily assess and confirm it using the mobile orientable photovoltaic prototype proposed for this work (figure 3).

The students can program the robot that controls the position and orientation of the PV solar panel to not only scan the different directions in order to optimize the solar energy collection at a particular instant but also to adjust that positioning along the day, the weeks and months on a particular location. The voltage generated by the photovoltaic solar panel can be registered to further analysis and or to give feedback to the robot. This first contact with artificial intelligence, even at a very basic level, is a valuable experience for the students.

4. Conclusions

Increasing the awareness and knowledge about sustainable development and the use of renewable energy sources among young people is crucial to our modern societies.

It is of utmost urgency to increase scientific literacy in these subject in our society. Working with younguer generations is fundamental.

To use hands-on investigative activities in interdisciplinary contexts may effectively engage students in an active commitment in learning about these subjects.

Adding the novelty of robotics and artificial inteligency to the study of the physics of electrical energy production with photovoltaic solar panels adds to the motivation of the young learners in creative and critical thinking education environments.

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COVID-19 and the Plastic Crisis: Two Proposals for Environmental Education Approaches

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Abstract. COVID-19 brought a new reality and some problems that already existed intensified. This is the case of the plastic pollution crisis. Lockdowns and fear have led people to buy more disposable materials. In addition, there is another material that contributes to this plastic problem: disposable face masks. These accessories have become essential, but their improper disposal and massive use bring serious threats to ecosystems. Policies are needed, but we all have responsibilities as consumers, and here environmental education is of huge importance to raise people's awareness and give them the knowledge to be critical in this regard.

Keywords. Environmental Education, Face Masks, Plastic Crisis, COVID-19.

1. Introduction

1.1. Historical contextualization

We are in the 21st century, and the technology is in its most advanced stage, and brought enumerable benefits to society, but also new challenges and concerns. Like Richard Rhodes said in his book "Visions Of Technology: A Century Of Vital Debate About Machines Systems A", "technology is the application of science, engineering and industrial organization to create a human-built world" [1]. This field influences all types of communication, political decisions, education, industry, culture, economic, social, and health systems. Basically, it impacts all sectors of our society and, ultimately, human lives [1].

This idea of advance makes us feel empowered to control everything. Some of us think that we are a superior species, and that we can dominate the entire planet, explore all the resources, and make the economy grow faster and unlimitedly to satisfy the human thirst for power [2]. Technology is seen as the support of these expectations. But this idea is probably wrong as we do not have control of the earth system and we cannot explore it infinitely without consequences. Nature ends up contesting, and the appearance of a new pandemic in 2019 seems like another evidence of such.

COVID-19 is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and some of the explanations given for the emergence of this pandemic, as well as others, are the degradation of ecosystems and the fragmentation of habitats [3-4]. The human population is growing, overlapping its territory with the one occupied by wildlife, making humans more susceptible to being potential hosts of pathogens carried by wildlife species, which, in turn, might originate new zoonoses. Deforestation with the aim of opening space for crops and building infrastructures, illegal trading of wildlife, intensive domestic animal husbandry, and large-scale distribution of uncontrolled food of animal origin (e.g., wet markets), are all factors that are contributing to the emergence of pandemics like COVID-19 [4], which is being considered as devasting as the world influenza pandemic of 1918 [5]. COVID-19 became detectable in December of 2019 [6], and it was proposed that its origins traced back to a wet market in Wuhan city of Hubei province (China), possibly transmitted from an animal host [4]. However, there are more theories about its origin [6-7].

After the emergence of COVID-19, this Chinese city – one of the most populated in the country - became the epicenter of this human-animal relationship. The limited containment in the beginning, due to the inability of the Chinese authorities to accept the problem and to accurately outline the history and evolution of the first infections and contacts, caused the transmission rate to increase fast [8].

Rapidly, this outbreak spread through China and other countries, enhanced by the Chinese New Year migration [4]. On January 30th, 2020, the World Health Organization (WHO) declared the outbreak as a Chinese International Public Health Emergency [4]. Finally, the Chinese government implemented drastic confinement measures, which resulted in a decrease in the transmission rate. However, it was too late, and the virus had already crossed the borders of

many countries. In the first months of 2020, while in China the situation seemed to be better, in countries like Italy, Iran and South Korea the pandemic situation became very serious [4]. The latency period of about 2 weeks and the asymptomatic host individuals promoted this fast spread [9]. On March 11th, 2020, WHO declared COVID-19 a pandemic [10]. At this date, 118 000 cases of infection had been identified in 114 countries, 4 291 deaths had already been recorded, and the increasing rate of these numbers was notorious [10]. On March 13th, 2020, the WHO considered Europe the active epicenter of the pandemic [11].

Given the severity of this scenario, it was necessary to take measures to address this disease rapidly and effectively. WHO recommended some basic self-protection behavior that becomes essential, like the distance of at least one meter between people, the use of face masks, and the frequent wash of hands (with water and soap or with an alcohol based solution) [12]. Many countries decided to adopt more restrictive measures, including quarantines and curfews, vulgarly known as lockdowns [13]. Many countries in the Schengen Area also restricted free movement by setting up border controls [14]. In April, 2020, nearly 6 billion people worldwide were under some form of lockdown [13]. On June 29th, 2020, WHO warned that, the reopening of some countries' economies, accelerated once again the spread of the virus, in spite of many countries have made progress in slowing down the curve of spread [15]. On July 21st, 2020, the total number of COVID-19 cases worldwide was 14.8 million, with more than 600 000 deaths across six continents [9,16].

Meanwhile, in November, a vaccine from the Pfizer company – proved to have, approximately, 95% of efficacy against serious illness [17] – was approved in Europe [18]. On December 14th, 2020, the emergence of a new coronavirus variant was reported in the South of England, which was named variant of concern 202012/01. This variant was proved as potentially more infectious [19-20]. On January 2nd, 2021, this variant was found in 33 countries around the world. Twenty days later, the total number of COVID-19 infections reported worldwide reached 100 million; by this time more than 2.17 million deaths were registered [21]. In January 2021, almost 77 million vaccines had already been administrated (at least the first dose). Although the vaccine was a great conqueror of science, its contribution to controlling this pandemic needs yet to be assessed. At the time of writing, countries were still dealing with the severe consequences caused by the pandemic, not only in the public health sector but also at a social and an economic level. In fact, millions of jobs were lost due to the lockdowns [22] and, according to the World Bank, up to 100 million people (or even more) could fall into extreme poverty because of it [23].

1.2. Plastic Crisis

1.2.1. Pre-pandemic situation

The term "plastic" refers to a variety of synthetic polymers that, during manufacturing, are "capable of flow such that they can be extruded, moulded, cast, spun or applied as a coating" [24].

In 1907, a material named Bakelite was produced, which later originated the synthetic plastic materials we use today [24-25]. The interest in this new component rapidly increased as its potential was realized: cheap, easy to produce, resistant, malleable, high thermal and electrical insulation properties, and durable [26]. So, in the 1940s and the 1950s, plastics began to be produced on large scales and became more common [24,27]: they were used to package food, medicines, and other goods as well as in construction components and toys [28].

Over time, there was an evolution in this industry and other types of plastic emerged: polyvinylchloride (PVC), polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), among others [29]. Some plastics have chemical additives, like bisphenol A (BPA) and polybrominated diphenyl ethers (PBDE), which represent a threat to human health [24]. Today, plastics are a common component of so many products, which is the cause behind their large manufacturing and consumption. This is a problem as many plastics are not recyclable and need hundreds to thousands of years to degrade [27]. In 2017, a study showed that "8.3 billion tons of virgin plastics have been produced to date" of which "4.9 billion tons have ended up in landfills or natural environments" [29-30]. By being deposited in

the environment, they are compromising the ecosystems and posing a serious threat to living organisms [31]. Photographs and videos with marine animals entangled with plastic are somewhat common in media, but unfortunately, there are more effects caused by plastic. Examples include the intake of plastic which may cause a false sensation of satiety, asphyxiation, and other serious health consequences provoked by chemical toxicants in debris, as endocrine disruption, neurological damage, reproductive failure, development issues, muscle damage, immune impairment and cancer [31]. These threats have been reported in species from coastal environments but also in rivers, lakes, soil, and other ecosystems [32-33]. A study estimated the number of floating debris in the oceans to be around 5.25 trillion particles, weighing 268 940 tons [34].

But this environmental problem does not exclusively lay on plastic disposal. Instead, three stages should be considered: production, consumption, and waste management [30]. It is fairly easy to understand how inappropriate waste management may lead to pollution, but the problem does not start here. In fact, if there is no holistic perspective, it will not be possible to address this issue in a sustainable manner [30].

The production (Fig. 1) marks the beginning of the entire plastic cycle. In the United States of America (USA), Middle East and South-East Asia this production is mostly based on fossil fuels [30] whose environmental impacts are well-known [35]. Plus, plastic manufacturing increased drastically. For instance, in 1950, 2 million tons of plastic resins and fibers were produced worldwide [29,36]; in 2015, it was estimated that 380 million tons were manufactured [29]. Plus, only 1% of the 380 million tons of plastics are bio-based and biodegradable, which highlights the need for change [30]. These bio-alternatives face skepticism by costumers, who fear this to be a greenwashing stunt and who raise ethical questions arguing that these products can compete for the same biomass used for food production [30]. Also, they still have problems, as they are not completely biodegradable [37].

The consumption of plastics also plays a critical role in this environmental issue as the awareness and behavior of consumers can either aggravate or ameliorate this problem. In the case of the public, this awareness is more focused on the objects closer to their reality, like bags, bottles, and packaging. In fact, it is necessary for all stakeholders, consumers and industry, developing and developed countries to work together in a holistic way [30]. Of course, policies are essential and the key to solving this, but people have to be responsible too. There is a very important relation between the consumers and the market, and we know that many people simply do not think about it in their daily life, for numerous reasons, included "busy lives" and high prices on environmentally friendly products. Plastic pollution is a reflection of our behavior. It is therefore important to invest in measures that promote public awareness, since this approach has the potential to influence people to adopt environment-friendly attitudes and behavior [40-41].

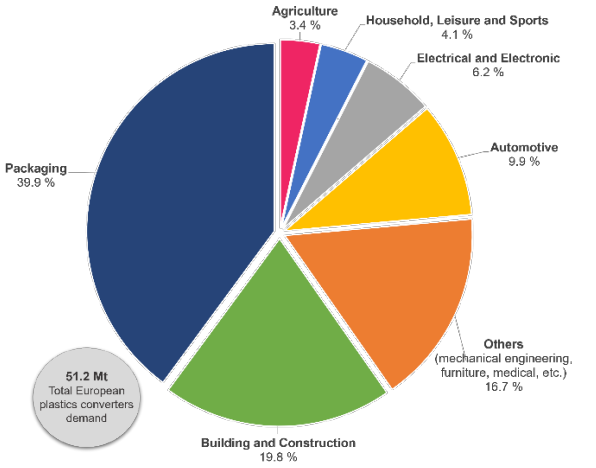

Figure 1. Percentage of plastic used in various economic sectors in Europe, in 2018. Image from [38], adapted from [39]

Regarding waste management, plastics started to be recycled around 1970 [42]. However, nowadays it is known that only a very low percentage of plastic can be recycled. In addition, this issue is amplified by the fact that there is a considerable portion of people in the world that do not recycle [30]. For instance, in the European Union (EU), only 30% of the plastic waste is collected and a large part of this is shipped to third countries [30]. Improving the waste management system is required to improve the overall management of plastics, but this is a complex task. For example, less than 50% of the plastic bottles consumed worldwide are collected for recycling, and only 7% of these are actually recycled into new

bottles [30]. This low percentage of recycled plastic is probably due to the fact that the market does not consider this a profitable alternative to the manufacturing of new plastic [43]. To aggravate this issue furthermore, specially in some developing countries, there is no integration of the informal waste sector, plus there is down-cycling of plastics (e.g., plastic waste is recycled into a less valuable product) [30]. Currently, 79% of the plastic waste ends up in the landfill or in the natural environment, while 9% are recycled and 12% are incinerated [44]. Incineration is another way of dealing with plastic waste, but this option also has a negative impact on the environment, releasing approximately 400 million tons of CO_2 per year, globally [30]. Hence, recycling is really the best choice to deal with plastic waste [45-46]. As we can see below, the use of these two methods has been increasing over time (Fig. 2).

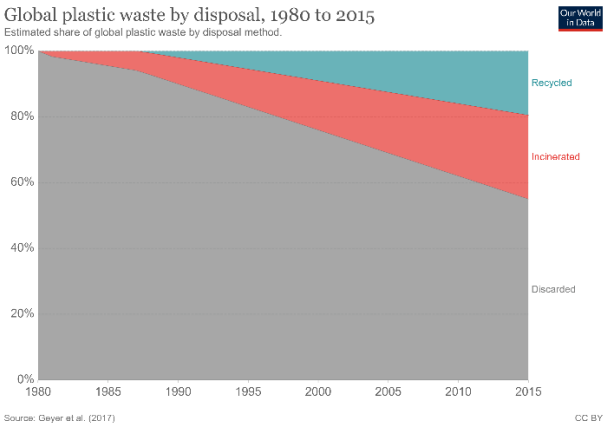

Figure 2. Relative percentage of global plastic waste by disposal method, from 1980 to 2015. Figure by OurWorldInData.org, used under the license CC BY 4.0. Data from [32]

It is estimated that the economic damage of plastic pollution in marine ecosystems is worth at least $13 billion annually (this includes cleaning up beaches and financial losses in tourism and fisheries) [47]. Due to the severity of this issue, several countries launched policies to address it. There are more policies aiming at addressing pollution directly, but as said before, managing plastic waste is not the only important action to take [30]. Much of these policies are focused on groups of objects. For instance, for bags, England, Ireland, Botswana, Portugal, the United States, Buenos Aires and Toronto implemented some public policies [30]. These policies increased from 20, in 2003, to 160, in 2018 [30]. In the case of the microplastics – "any synthetic solid particle or polymeric matrix, with regular or irregular shape and with size ranging from 1 µm to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water" [48] – there are growing regulations to ban these materials from being incorporated in products [30]. An example of an instrument that is used to deal with this plastic problem is the MARPOL Convention (International Convention for the Prevention of Pollution from Ships), whose annex V has completely banned the disposal of all types of plastics and other garbage by ships in the oceans [27,49]. Regarding recycling, European Member States have been applying a directive to encourage the consumers to recycle and providing measures to prevent the production of packaging waste too [42,50]. In the case of the EU, it was published "A European Strategy for Plastics in a Circular Economy" [51], in order to put into practice pro-environmental policies regarding the plastic issue. A series of objectives was elaborated, within which turns all plastic packaging in EU markets reusable or easily recycled, until 2030 outlining new rules and economic incentives [51]. In 2019 it was launched the Directive 2019/904 by the European Parliament and the Council aimed at reducing the impact on the environment and human health of various plastic products (single-use plastics, products containing oxo-degradable plastics and fishing gears with plastic) and in promoting the circular economy. Reduce consumption, increase restrictions for placing products in the market, define market requirements, place a greater responsibility on producers, separation and collection, and invest in awareness raising measures are the strategies to meet the objectives [52].

Although some advances have been made, they are not enough to sustainably deal with plastics. In an attempt to manifest their discontent, some people created actions like "plastic attack", which consist in a form of protest where people leave the packaging of their products in the supermarket, after buying them. This movement started in the United Kingdom [30] and is one of the examples of how public opinion can force the industry and the market to take action.

1.2.2. During the pandemic situation

In spite of all these positive strategies implemented to achieve the goal of halting the impact of plastics in the environment, the emergence of this pandemic stalled a lot of this advance.

The plastic had and still has at the time of writing, a huge importance to protect humans against COVID-19. Personal Protective Equipment (PPE) had an important role to avoid the propagation of the virus. Among these materials are face masks, latex gloves, shoe covers, face shields, and others [53]. Plus, the public started to realize that plastic materials are more hygienic than others, which, along with the convenience factor, led to an increase in the use of disposable plastics [54]. On another hand, online delivery became more frequent, contributing to the increase of plastic waste (e.g., food and other goods packaging, plastic bags) [55]. However, the massive use and the inadequacies in waste management, as described above, could lead to improper disposal becoming plastic wastes a threat to the environment and to public health [57].

Companies, mainly the ones involved in the plastic industry, saw this pandemic as an opportunity to produce and sell more plastic [55] since some governments also promoted this by rolling back some plastic ban regulations [56]. For instance, Starbucks, that has banned reusable cups temporarily [57], and Illinois grocery stores that banned the use of reusable bags [56]. In addition, the plastic industry, also used this period to influence public's opinion, and for example, the Canadian Plastics Industry Association (CPIA) claimed that single-use plastic bags and other plastic packaging are more hygienic and require fewer resources during production than reusable alternatives [56].

Some national government regulations about measures to address the plastic issue also suffered delays. For instance, in Portugal, the reduction of disposable plastics in the restaurant sector was supposed to start in 2020, but, because of pandemic, this was delayed [58, 59]. In Massachusetts, there was the reintroduction of plastic bags for some retailers [56]. Other states of the USA have rescinded or delayed plastic bag bans too [56]. Similar measures were seen in Hawaii, Canada, South Australia, Italy, Scotland, and United Kingdom [56].

So, the pandemic led to a general increase in plastic waste and medical waste, not only due to enhanced consumption but also because collection, separation and recycling centers and waste treatment facilities were not so active [53, 56]. It is estimated that, globally, around three billion face masks are disposed of every day and that 1.6 million tons of plastic waste are produced daily since the start of the pandemic [53]. Besides, the decrease of employees in this area and capacity constraints due to the pandemic led to inadequate treatment of waste that ends up polluting the environment [55]. During the pandemic, incineration seemed like a practical solution, however reducing, reusing and recycling continued to be the recommended approach, and the incineration structure could not complement the huge rise of plastic generation [55]. Another factor that contributed to the increase of plastic production, was the decrease of the oil price caused by the pandemic constraints, which led to the decrease of the value of virgin plastic in comparison to the recycled ones [55].

We are seeing plastic with the wrong eyes, considering its use as a plethora [53]. But it seems that we are going somewhere now. Fortunately, at the time of writing, there was an advance regarding plastic policy. In Portugal, the government is starting to pay the due attention to this big issue, alongside other European countries. The enforcement of the Directive 2019/904 and of the Portuguese Law 76/2019, September 2nd is finally taking place [52]. According to "decree-law nº. 22-A/2021, March 17th" [59] the restaurants, caterings and drink places have until July 1st, 2021, to adapt and to apply these regulations [58], in particular in what regards single-use plastics. These updates enter into force in Europe on July 3rd [60]. Also, the bags from any material are not anymore free in stores, and in the takeaway services the consumers can use their containers [61]. New Zealand is another country that launched a ban on plastic plates, bowls, straws, fruit labels, bags, cotton buds, and other single-use plastics [62]. In this follow-up, some countries already started in this way before the pandemic [63].

Although there was some advance in plastic policies before and after the pandemic appeared, little was done regarding specifically the issue of disposable face masks. The incorrect disposal of these items in streets, gardens, beaches, and other public places is notorious [64]. In fact, the World Wide Fund of Nature (WWF) published that "if just 1% of the masks were disposed of incorrectly and dispersed in nature, this would result in as many as 10 million masks per month polluting the environment" [65]. If one mask has approximately four grams, this would mean that, per month, 40 000 kg of plastic would be deposited in nature [65]. It is a serious problem that is getting bigger right in front of us [65].

The pandemic can be seen as an opportunity for humans to learn and respect the environment. A time to take advantage of the effects of quarantine periods – like the decrease in the carbon footprint, the improved air, and water quality – and revert the tendency of plastic pollution [53]. Some world economies are working towards this goal. For example, the European Union committed to devoting 25% of its economic stimulus for the pandemic crises to climate-friendly measures [55]. Meanwhile, South Korea committed to reduce greenhouse gas emissions to net-zero values by 2050 [55]. But, once again, regarding the disposable face masks not much has been done.

2. Environmental Education Strategies

Today, it is widely acknowledged that public engagement plays a vital role in Nature conservation [66-68]. For instance, people that are interested and informed about conservation can demand better conservation practices from the government [66, 68]. Besides, in order to address the underlying causes leading to biodiversity loss (including pollution), society must change its behavior [66-67]. Increasing public knowledge constitutes a way to foster willingness to that change and adopt ecological behavior [40,66-67].

Environmental Education has three main lines of action: (1) transmit information about the environment to citizens, (2) provide tools to help them improve and change their habits, and (3) encourage critical thinking so they are able of taking their own conclusions and identify problems [69].

Given this context, environmental education seems well-positioned to help to address the current plastic crisis. Hence, in order to increase the awareness of citizens about the problematic of disposable face masks, two environmental education activities were prepared and are being proposed.

2.1. Face mask Degradation Experiment

This hands-on, inquiry-based activity was developed for an audience of secondary school students, who, ideally, would implement it during classes.

The main goal of this experiment is to raise awareness among the students about the plastic crisis in general and also to inform them about the issue of disposable face masks. It is expected that, by having a hands-on experience that demonstrates the low degradability rate of face masks once deposited in the environment, the students will become more aware of this issue and, ultimately, critically think about their face mask choices. By carrying out this experiment, students will be able to answer the following questions:

- Is it possible to detect signs of biodegradation in disposable face masks in the environment?
- Are the two types of disposable face masks identical in regards to their biodegradability?

For the experiment, the students will need:

- 12 surgical masks
- 12 respiratory masks (like KN95)
- Shovels
- 1 camera
- Electronic magnifier
- Incubator
- Weighing scale
- Monitoring notebook
- 1 vase or garden
- Rocks (or small signboards)

In order to execute the experiment, students should follow the steps described below:

1. Organize the face masks in groups as indicated: Control Group S: 3 surgical face masks; Control Group R: 3 respiratory face masks; Group 3-S: 3

surgical face masks; Group 3-R: 3 respiratory face masks; Group 6-S: 3 surgical face masks; Group 6-R: 3 respiratory face masks; Group 9-S: 3 surgical face masks and Group 9-R: 3 respiratory face masks. These numbers (except for the control groups) translate into the number of months that face masks will be buried in the soil.

2. Photograph, weigh, and observe with an electronic magnifying glass the face masks belonging to all the groups. The students must then write in their monitoring notebook the measurements and other data that they think are important (e.g., drawings of what they see, comments about the face mask texture, color, etc.)
3. The next step is to bury them. Students should dig three holes (one for each dig up period), with a depth of approximately 15 - 20 cm. In one hole, the face masks assigned to groups 3-R and 3-S should be buried. Then, the hole should be covered and a rock numbered “3” should be placed on its top, above the soil. In the second hole, all face masks assigned to groups 6-R and 6-S should be buried. Like before, the hole should be covered and a rock placed on top of it, but this rock should be painted with the number 6. All the remaining face masks should be buried in the last hole, which must then be covered. On top of this last hole, a rock numbered “9” should be placed. The numbering in the rocks is intended to make it easier to identify the location of face masks as well as to provide a reminder of when they have to be collected.
4. After 3 months, the face masks buried in hole number 3 should be carefully dug up (example in figure 3).
5. Photograph the unburied face masks, observe them under an electronic magnifier glass, and write down all the relevant information.
6. Carefully clean the face masks and place them on an incubator regulated at 100º C (if this temperature is not possible, use at least 60°C) for at least 12 hours, in order to remove the humidity. Afterwards, the face masks should be removed and weighted.
7. The steps 4 to 6 must be repeated for all the groups once reached the respective unburying date.
8. After unburying and analyzing all face masks, students should analyze all collected data to answer the previously formulated questions.

Figure 3. Masks after being dug up from the ground

To finalize this experiment, the teacher mediating it should promote a discussion about the obtained results as well as about the advantages and disadvantages of each type of face mask available in the market including the reusable ones.

2.2. Itinerant exhibition – “Disposable masks: The Problem of the Solution”

The second proposal is to design an itinerant exhibition and opening it to the general public.

The goals of this exhibition consist in

- Raising awareness among the public about disposable face mask pollution and their correct ways of disposal.
- Capacitating citizens to critically think about which is the most appropriate face mask choice for them.

The concept of the exhibition is divided into four modules. Below, it is described the different ideas behind each of them.

MODULE 1 – The Problem with the Solution

This first introductory module, which will welcome visitants to the exhibition, will entail two large format prints:

- One portraying a compilation of several pictures of face masks in the environment.
- Another entitled "The anatomy of a facemask", which schematically presents the different types of face masks and their composition. This will include microscopy images showing the small fibers that compose face masks.

MODULE 2 – The Biodegradability of Face masks

This module will consist of large format prints that showcase, through a photography storyboard, the methods and results obtained by carrying out the biodegradability experiment described in section 2.1. This will include colored photographs taken with a digital camera as well as artistic, black and white photographs created using a pinhole camera.

MODULE 3 – Which is the Best Face mask Choice?

This module will include a hands-on activity called “Masks in cubes”. In this activity, there are four acrylic cubes; each one has a different type of face mask inside, including surgical face masks, respiratory face masks, homemade cloth face masks and certified cloth face masks. On one side of each cube, it will also be displayed some information, in an infographic format, regarding each face masks’ degree of protection, price, and sustainability. Here, visitants will be challenged to order the cubes from the worst face mask choice to the best, considering all the criteria they find relevant.

Near the end of this module, short messages will be displayed concerning the broad theme “The environment is also in your hands”, to highlight and promote critical thinking about the importance of citizens' behavior towards this problem.

MODULE 4 - BioImages: Sustainable Design and Photography Practices

In this module, it will be explained how the pinhole photographs shown in module 2 were created. For that purpose, several elements are included:

- Hands-on activity called “Guess the Smell”: several opaque containers will be displayed to visitors, with each one holding a different compound used in the making of bio-photographic developers (e.g., coffee, spearmint, and thyme). The challenge here will be for the public to identify the compound using their sense of smell.
- Large format print that illustrates, step by step, the process of preparing the caffenol developer.
- Large format print that uses storytelling to introduce the historical context of the appearance of these bio developers, by presenting Dr. Scott Williams and the Technical Photographic Chemistry 1995 Class [70].
- Large format print about the educational project named “Bioimages”, which has a focus on eco-friendly art practices. Moreover, its goal is to develop sustainable design and photography practices by using biomaterials and recycling methods.
- Showcasing of eco-objects used in the Bioimages project, where people will be able to interact with and be inspired by their eco-design philosophy. These eco-objects will be displayed side by side with their regular versions (e.g., common mortar *VS* eco mortar).

3. Conclusion

The pandemic highlighted our imbalance with the environment. In our political agenda, the environment has to be prioritized as in our daily lives. In the case of plastic, we must take responsibility and be conscious consumers. In this regard, Environment Education is very important to bring these environmental issues to people, in order to make them capable of being critical and confident about their choices, taking into account the environment too. This is what we aim to achieve with these two proposals.

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Joint Training on Judo for Deaf and Ordinary Children

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Abstract. The experience of joint training on judo both deaf and ordinary children 6-10 years old is given in this article. The first joint training on judo has been started five years ago at Complex Children and Youth Sports School #12 (Kharkiv, Ukraine) for children of the age 10-14. Later it was decided, that such joint training must be for younger children. For last three years joint training on judo are taken place in Kharkiv Special School #5 for deaf children. New types of communications and friendship between deaf and ordinary children were noticed and described. Improving deaf children's physical fitness was mentioned.

Keywords. Deaf Children, Joint Training, Judo, Kata Judo, Competition.

1. Introduction

Judo is a traditional Japanese sport that is very popular all over the world both among men and women. It is an Olympic sport for men science 1964 and 1992 for women. Judo is also a Paralympics sport science 2004.

In Ukraine judo became popular during last 30 years. Now we have several famous sportsmen in judo, among them are Daria Bilodid - the 2019 World and the 2019 European gold medalist in the 48 kg division, Georgii Zantaraia – the 2009 World gold medalist in the 60 kg division, Roman Gontyuk - he won a silver medal in the half-middleweight (81 kg) division at the 2004 Summer Olympics and bronze medal in the half-middleweight (81 kg) division at the 2008 Summer Olympics in Beijing [1].

Judo is one of the sport in Ukrainian school that included to the school physic all training program. Also there are a lot of governmental as well as private judo schools and groups in Ukraine. For example, in Khakiv (the second biggest city of Ukraine we have more than 30ty private judo schools and 10 Complex Children and Youth Sports School there are sections on judo.

2. Inclusive sport in Ukraine

Deaf children are the easiest for integrated in youth community. Some of them are able to understand our speak thanks for lip reading (speech reading), other use modern smartphones for communication like “write and read”. Between themselves deaf children often use Ukrainian sign language, that they learn in special schools.

Inclusive education for deaf children with ordinary children in secondary school is possible only if deaf children are good in lip reading and speaking or have cochlear implant (CI). From years to years the number of such children rise, thank for different government programs in the sphere of inclusive education.

Inclusive sports, when deaf (without CI) or children with other special needs and ordinary children have joint training – at the same time and place together – are not common thing in Ukraine. The reasons are:

1. lack of qualified trainers who can combine the ordinary children and children with special needs training ;
2. lack of methodological basis for such joint training;
3. technical barriers in buildings and outdoor that make it impossible for children with musculoskeletal disorders to get joint training;
4. a considerable distance from the children with special educational needs places study to the places of joint training, because usually it is the children with special educational needs who come to the training of ordinary children;
5. lack of motivation for coaches, parents and support staff.

3 Project start and development

The first joint training on judo has been started five years ago at Complex Children and Youth Sports School #12 (Kharkiv, Ukraine) for children of the age 10-14.

Deaf children comes at Complex Children and Youth Sports School #12. There is big, safety, with good equipment (tatami) special judo class. Deaf teenagers with escort teacher comes from Kharkiv Special School #5 that situated not far from Complex Children and Youth Sports School #12 – the distance between both schools is only 500 meters. Such joint trainings was only once or twice times in month and wasn't able to give real judo skills. But it was mentioned, that deaf and ordinary teenagers communicate well, they add each other category "friends" in social nets.

It was decided, that such joint training must be for younger children and at Kharkiv Special School #5. The first problem was to find out money for making safety judo class at Special School #5. As there is no governmental or municipal program for joint sport training, we decided to raise funds from philanthropists.

Famouse Kharkiv photographer Pavlo Dorogoy took a free photos series from joint trainings on the Special School #5 basis in an outdated gym (Fig. 1-3). Than this photos was used in the promotions and the German charity fund provided funds for the purchase of tatami and special uniform judogi for deaf children.

Figure.1. Judo technique show ordinary (left) and deaf (right) children (by Pavlo Dorogoy)

For last three years joint training on judo are taken place in Kharkiv Special School #5 for deaf children age of 6-10 years. They take place twice a week; there are 10 deaf children and 10 ordinary children on this joint training. Coach - Serhii Tyshchenko, master of sport, II dan, graduate of IJF Academy (2017).

Figure.2. Joint training deaf and ordinary children (by Pavlo Dorogoy)

Figure.3. Joint training deaf and ordinary children at outdated gym (by Pavlo Dorogoy)

4. Technique KATA in joint judo training

KATA (形, kata, forms) are pre-arranged patterns of techniques and in judo, they are all practised with a partner.

Their purposes include illustrating the basic principles of judo, demonstrating the correct execution of a technique, teaching the philosophical tenets upon which judo is based, allowing for the practice of techniques that are not allowed in randori, and to preserve ancient techniques that are historically important but are no longer used in contemporary judo [1].

In Ukraine championships on KATA holds only last several years, but its population is growing.

Using of KATA as base for joint training allows you (Fig.4):

1. give children good physical condition without significant injuries;

2. make mix pairs from deaf and ordinary children – they know what to do and don't need speaking and listening for training;
3. to expose mixed pairs at competitions of different levels without indicating that one of the partners is deaf.

As there are not a lot of participant of KATA competition, there is a big chance to win. Every little victory of deaf children in the world of ordinary children helps them feel equal.

Figure 4. Training on KATA deaf and ordinary partners

Figure 5. Celebration the last day at joint summer judo camp

5. Results of the project

The main results of joint training on judo are:

1. full integration of deaf children from Kharkiv Special School #5 to society of ordinary children. Ordinary children often invite deaf children to different parties; they walk in parks together with parents; visited cinema;
2. socialization of deaf children – the are not afraid to communicate not only with ordinary children, but also with adults in different places and situations;
3. 2021 summer judo camp at the Azov seaside also was both for deaf and ordinary children without parents (fig.5) – deaf children's parents are not afraid to delegate their children;
4. deaf children stop afraid jump and rolls after two years judo training. Deaf children afraid to lost tactile connection with ground (floor) – it's because of some dysfunction of their vestibular apparatus. Judo and KATA are based on rolls and throws, so during trainings deaf children should study them and not afraid them.

6. Acknowledgements

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Interrupted Case Studies in Undergraduate Chemistry Teaching

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Abstract. This work presents the application of interrupted case studies, created from the content of research articles from the Química Nova Journal, within the theme of "water resource contamination by heavy metals and its effects on human health". Due to the Covid-19 pandemic, the application occurred through virtual environments. Rich debates and discussions about many chemistry contents can be observed. Analyses of the solutions presented by the students showed correspondences in excerpts from the research articles that gave rise to the cases, which demonstrates the adequacy and relevance of the activity.

Keywords. Interrupted Case Method, Chemistry Teaching, Environmental Chemistry.

1. Introduction

The case study method is ever increasingly being used for formal instruction in science teaching, where students are encouraged to discuss dilemmas faced by characters through narratives and to find and argue in favor of solutions. Based on this, the method provides opportunities to raise students' curiosity, the desire to continue interacting, identify problems, search for information, question and compare results, propose solutions to problems and argue [1-3].

There are several types of case study. One of them is the interrupted case method, which presents the problem in a progressive disclosure format. According to Herreid [4], in this method, the narrative can be developed by following the content of a research article, and therefore the interrupted case portrays a problem that was faced by researchers in a certain area.

This work aims to report the development of teaching activities based on solving interrupted case studies, applied to second semester students of an online Chemistry undergraduate degree course, due to the restrictions imposed by the COVID-19 pandemic.

2. Participants and Settings

Three interrupted cases were created based on three research articles from the *Química Nova* Journal [5-7], which address contamination of water resources by heavy metals and its effects on human health.

The case studies were divided into four parts that have two different sections: a narrative, through which information about the problem was presented; and questions, which supported the research activities and search for solutions. The parts were constructed aiming to contemplate the application steps proposed by Herreid [4], which, in short, include raising hypotheses (Part I), outlining an experimental procedure (Part II), arguing the outlined experimental procedure (Part III), interpreting data, discussing results and evaluating solutions (Part IV).

The class was divided into groups of four-five members and eight meetings were held to solve the case studies on Google Meet and Tidia-Ae (Table 1).

Table 1. Activities carried out for the case studies

Meeting	Activities
1	Instructions for resolution of cases
2	Part I - Raising hypotheses
3	Part II - Outlining an experimental procedure
4	Part III - Arguing the proposed experimental procedure
5	Part IV - Interpreting data and evaluating solutions
6	Feedback and Instructions for preparing an oral presentation of the case resolution
7	Oral presentation of the case resolution
8	Final feedback

3. Interrupted Case Study Resolutions

Initially, the fact that the students participated actively in the meetings is highlighted. From the discussions held on Google Meet and the written material handed in by the students on Tidia-Ae, it can be observed that the cases provided rich debates among students and stimulated participation in the activities. From the application, chemistry

content associated with the theme of the cases was discussed, such as bioavailability of metals, bioaccumulation, biomagnification, sediments, and maximum recommended and maximum allowed values, etc.

Based on what was observed in the oral presentations for the case resolution (Table 1 - Meeting 7), next we present details for the resolution of one of the cases, entitled *Lead in the River*, created from the content in Cotta et al. [5], and which was solved by group one (G1), comprising four students.

The case tells the story of Victoria and Igor, two graduate students in Chemistry, who decide to visit Mr. Paulo, a friend who works in the Divina Ecological Park. Mr. Paulo tells his friends that he was intoxicated with lead, and the main suspicion of the doctor in the region of the origin of the contamination refers to the water that supplies the village where he lives. Genuinely concerned about the situation of their friend, Victoria and Igor volunteered to investigate the dilemma.

Searching for information, Victoria and Igor discover that there are several lead mines in the park, wich were explored ten years ago by Garden Mining. These activities involved extracting galena, lead processing and disposal of residual materials along the banks of the Garden River. The main problem of the case is to verify the concentration of lead, among other metals, in the sediments of rivers that supply the village where Mr. Paulo lives, relating it to the presence of lead mines in the locality.

G1's oral presentation showed the group's resolution process for the case, using a total of 12 slides, presented in 14 minutes. Observing in more details the *Results and Discussion* and *Conclusions* sections of the oral presentation, initially, the presenter (student) introduced an overview of the obtained results, by reproduction of two tables provided in Part IV of the case study, which shows concentrations of aluminum, cadmium, chromium, copper, iron, manganese, nickel, lead and zinc, in the rivers sediments.

Then, the presenter (student) focused his explanation on the results obtained for lead, zinc, and copper, since these are the metals associated with the extraction of galena (PbS), the mineral explored in the region. Three new tables were thus presented, showing the concentrations of the highlighted metals, relating the results with the location of six sampling points (Figure 1) and making comparisons with maximum recommend values (MRV). At the end, two graphs with lead and zinc concentrations in the pseudototal and bioavailable fractions along the sampling points were presented.

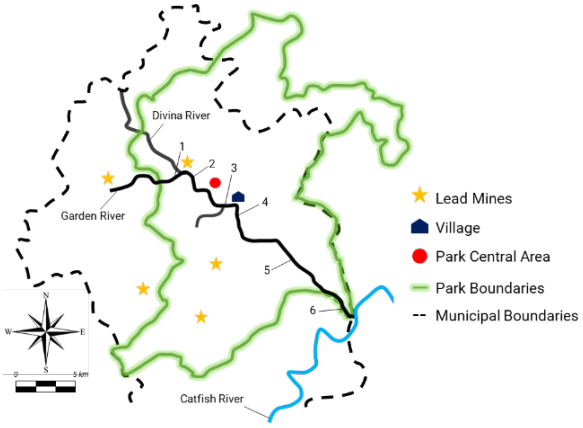

Figure 1. Map of the study area (Divina Ecological Park) in the case study *Lead in the River*

The main observations highlighted by the group include higher concentrations of metals at sampling points 1 and 2, which exceed MRV proposed by Crommentuijn et al. [8], justified by the proximity of the points to the lead mines; decrease in concentrations along points 3 and 4, and the stabilization of values in points 5 and 6, due to deposition and transport of metals along the Divina River.

The group concluded that the river was contaminated, especially by lead, due to exploration carried out in the mines in the past. Analyzing the presented observations, they were considered adequate, as they find correspondences in excerpts from the research article that gave rise to the case [5], such as the following assertions: "pseudototal concentrations of Cu, Zn and Pb, and bioavailable concentrations of Zn and Pb were above the maximum allowed value [...] Points 1 and 2 had the highest concentrations of these metals [...] The sediments evaluated in this study are highly contaminated in some places" (p. 43-44).

The group mentioned the river's flow as a factor that could contribute to the spread of contamination from points 1 and 2 to the rest of

the river. Although there is no mention of flow effects in Cotta et al. [5], the information does not have a conceptual problem, as it finds support in the literature [9-10].

Finally, the case study *Lead in the River* reported the contamination of human beings by lead. When verifying the contamination of the river by the metal, the group also understood that lead was bioaccumulating in species that have contact with the river. It is believed that this information does not have sufficient support in the data presented and that the group may have confused the concepts of bioaccumulation and biomagnification, discussed during the case study resolution.

Bioaccumulation is the excessive assimilation of toxic substances by the tissue of organisms, and biomagnification, the progressive accumulation of toxic substances from one trophic level to another along the food chain. From this, the fact that the contamination comes from the river, that is, from the organisms that live there, to human beings, more effectively supports the finding of the occurrence of the biomagnification.

4. Conclusions

This work presents the development and application of interrupted case studies created from research articles from the Química Nova Journal, whose theme was the contamination of water resources by heavy metals and its effects on human health. Each case was divided into four parts considering recommendations made by Herreid [4].

Due to the Covid-19 pandemic, the application was carried out through Google Meet and Tidia-Ae virtual environments. Eight meetings were held and led to making an oral presentation to explain the resolution given by each group to their respective case, and G1 solutions for the case study *Lead in the River* are discussed in this work.

The information presented in the in the written material, as well as in the oral presentation, was aligned and coherent with the content of the research articles that gave rise to the cases [5-7], demonstrating the adequacy of the activity to the level of knowledge of second semester students and its relevance to the development of content and skills of different natures, including argumentation.

Based on this, this work highlights the possibility of elaborating and applying a didactic sequence based on solving case studies, which have as a focus the desirable authenticity to develop contents and develop skills in Chemistry teaching.

5. Acknowledgements

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Koffeeco – A Residue Treating the Environment

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Abstract. All over the world, millions of people consume coffee beverages every day. This leads to the massive production of coffee grounds waste which are commonly discarded. Therefore, further investigation ought to be taken in order to reuse this waste and transform it in an environmental remediation agent. Our project aims to use coffee grounds waste to produce both activated carbon and green zero-valent iron nanoparticles (gnZVI) that could be used for environmental remediation. We plan to evaluate which of these approaches is more effective in terms of the removal Carbamazepine (an anticonvulsant) from contaminated water.

Keywords. Activated Carbon, Adsorption, Coffee Grounds, Nanoparticles.

1. Introduction

Living in the 21st century, water pollution has proven to be one of the major problems humankind has to deal with. Due to that, it is imperative that scientific communities and common citizens combine efforts in order to find innovative solutions to this issue. Regarding this subject, both activated carbon and green zero-valent iron nanoparticles (gnZVI) have raised attention because of their unique properties and potential applications.

Nanoremediation involves the utilisation of reactive nanoscale materials for the transformation and detoxification of pollutants through chemical reduction or catalytic processes [1]. Nanoparticles have reduced dimensions and a huge superficial area, which enables them to infiltrate in the smallest ground pores. Studies have reached the conclusion that these highly reactive particles are quite effective in terms of the reduction of organic materials in water and soils [2].

Several methods can be used for these nanoparticles' production, namely: top-down methods [2] and bottom-up methods. Top-down methods involve the production of nanoparticles through mechanical and/or chemical processes, which are expensive and involve specific equipment. On the other hand, bottom-up methods consist in the production of gnZVI through chemical reactions of synthesis.

Within this method, there are two different approaches: the traditional method and the green method. The first one involves the reaction between iron (III) or iron (II) solutions with sodium borohydride [2], which is tremendously dangerous for the environment and for the operator, while the second one uses aqueous extracts with high reduction capacities that are obtained from natural products, in this case, coffee grounds, and that are "eco-friendly".

Apart from nanoparticles, activated carbon ought to be equally investigated, and can as well be produced from coffee grounds waste, which contains caffeine, tannins, and polyphenols and may cause environment pollution if not properly disposed [3].

Activated carbon (AC) has unique chemical and textural properties and plays a significant role in terms of adsorption processes. AC production can be done by chemical or physical activation. In the latter, the precursor is carbonized at temperatures above 500ºC and then activated at higher temperatures (700-900 ºC), using CO2 or water vapor, as an activating agent. Oppositely, in chemical activation, the precursor is treated with chemicals, such as ZnCl2, KOH and H3PO4, which are the most commonly used industrially. Then, the precursor is activated at temperatures ranging from 450º to 600ºC [4].

The production of activated carbon from coffee grounds is widely attractive as it makes use of something, generally, regarded as waste that ends up in landfills. The whole process is environmentally friendly, since there is no need to explore natural resources, such as wood and mineral rocks.

Therefore, the main objective of this project is to evaluate the viability of using nanoparticles, produced using the green method, and activated carbon, to remove Carbamazepine from contaminated water, and decide which of these approaches is more advantageous.

2. Materials and methods

2.1. Materials

In our experiments, we used coffee grounds waste, which we collected after preparing coffee beverages. All reagents used, such as potassium hydroxide, ammonium iron(iii) sulfate dodecahydrate and methanol, were of analytical grade, and were used without further purification. All of them were provided by ISEP (Instituto Superior de Engenharia do Porto). Distilled water was used to prepare every solution needed.

2.2. Preparation of the carbamazepine solution

Carbamazepine, whose chemical formula $C_{15}H_{12}N_2O$, was used as a pollutant. The chemical structure of the medicine's molecule is shown in Fig. 1. The medicine's solution was prepared using distilled water and methanol and its concentration was determined through UV-Vis spectrophotometry, at 285 nm. The mass concentration of the prepared solution was of 105,8721 mg dm^{-3}. The calibration curve used for both tests, with nanoparticles and activated carbon, is represented by Equation 1.

$$\text{Absorbance} = 0{,}05163 * \text{Concentration} - 0{,}0113 \quad \textbf{(Equation 1)}$$

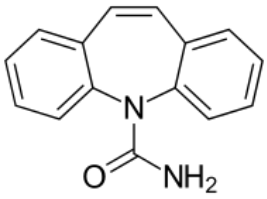

Figure 1. Carbamazepine's molecule [5]

2.3. Synthesis and characterization of gnZVI

The gnZVI production involved a mixture of a natural antioxidant extract with an iron (III) solution (0,1 mol L^{-1}) that transformed the Fe^{3+} into Fe^0. The natural extract was produced through a solid-liquid extraction with coffee grounds and water at 60ºC, attending to the premise of using a green method of production and considering solvent costs. The concentration of the extract was optimized, and so was the proportion extract volume: iron (III) volume, taking into consideration UV-Vis spectroscopy at 750 nm. Spectrometric analysis at 285 nm was used to accurately quantify the content of the medicine in the solutions.

2.4. Analysis of carbamazepine's adsorption with gnZVI

The experiments with the gnZVI were performed in Erlenmeyer flasks containing 100,0 ml of the Carbamazepine solution (c_m = 105,8721 mg/dm^3). Different amounts of the natural antioxidant extract and the iron (III) (0,1 mol dm^{-3}) solution were added to the contaminant solution, as shown in Table 1.

Since the absorbances read were above 1,4 (the maximum value possible for the calibration curve used), it was necessary to make dilutions (the dilution factor was 2, as the proportion was of 1:1). 0,7 ml of each Erlenmeyer flask and 0,7 ml of distilled water were placed in the quartz cuvette, which was used in spectrophotometric analysis. The concentrations of the medicine in the diluted samples, during the experiments, were determined through Equation 2 and the results obtained are displayed in Fig. 2.

Table 1. Trial registration for the nanoparticle's experiments (A-absorbance; C- mass concentration (mg/dm^3))

Trial	Volume of the contaminant solution	Volume of the iron (III) solution	Volume of the extract	Amount of gnZVI
1	100,0 ml	1,25 ml	5,0 ml	7,0 mg
2		2,50 ml	10,0 ml	14,0 mg
3		3,75 ml	15,0 ml	21,0 mg
4		5,00 ml	20,0 ml	28,0 mg

The relation between the percentage of the medicine's removal from the solution (calculated as shown in Equation 2) and the time in which the reaction occurred, is illustrated in Fig. 2.

$$\%\, Medicine's\ removal = \left(\frac{C_m\ initial - C_m\ final}{C_m\ initial}\right) * 100$$

$$C_m\ initial = 105{,}8721\ mg/dm^3$$

$$C_{m\ final} = C_{m\ calculated\ using\ the\ calibration\ curve} * 2$$

C_m initial=Initial concentration of the medicine's solution

C_m final =Final concentration of the medicine's solution

(Equation 2)

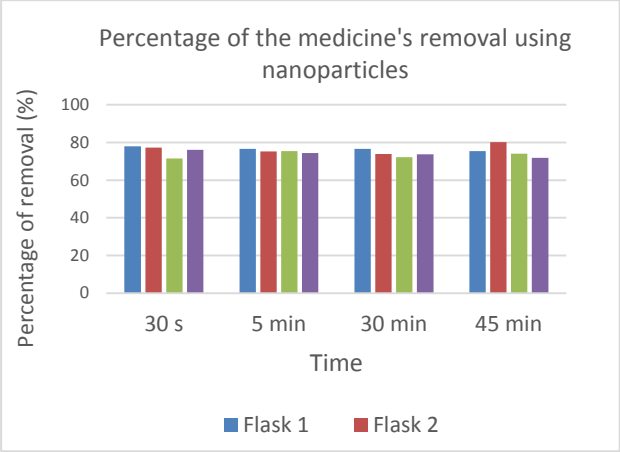

Figure 2. Percentage of the Carbamazepine's removal using gnZVI

These results prove that gnZVI can remove nearly 80% of the medicine from contaminated water, after 30s of reaction. Also, it is possible to conclude that after 30s of the reaction, no further alterations on the Carbamazepine's removal are observed, since the gnZVI are highly reactive and tend to react with the oxygen dissolved in the solution's water. In regard to the amount of nanoparticles used, it can be concluded that increasing the amount of gnZVI does not lead to a greater percentage of removal.

2.5. Preparation of carbon materials

Activated carbon was likewise produced from coffee leftovers, which were subjected to high temperatures. The raw material, coffee grounds waste, was firstly placed in a pyrolytic reactor and a quick heating ramp was set: in 30 minutes time, the temperature rose from 20ºC (room temperature) to 600ºC, which was maintained during one hour. The atmosphere within the reactor remained inert due to a continuous flushing of nitrogen. Three experiments were performed to obtain 28,2725g of the carbonized product, and the average yield was of 24,15%. The yield of the activated carbons was determined from Equation 3, and Mp stands for the mass of the precursor (g) and M_{CG} for the mass of coffee grounds waste (g).

$$Yield_{AC}\,(\%) = \frac{Mp}{M_{CG}} * 100 \quad \textbf{(Equation 3)}$$

Potassium hydroxide (5,9258 g) and deionized water were, subsequently, added to the precursor, because of this reagent's capacity of creating pores in the carbonized product. During the physical activation process, that involved carbonization and activation, high temperatures were required and, consequently, the yield of production was low [4].

Afterwards, the impregnation process was carried out in a specific stove, at 100ºC, in order to maximize the adsorption of the activating agent by the precursor. Then, in the activation process, the carbonized product was afresh taken to the pyrolytic reactor, but the temperature was of 900ºC, and the process took four hours to conclude. No sooner was the activated carbon removed from the reactor that it was washed, filtered, and taken to the stove again, at 100ºC.

2.6. Analysis of carbamazepine's adsorption with activated carbon

The experiments with the activated carbon were performed in Erlenmeyer flasks containing 100,0 ml of the prepared Carbamazepine solution (c_m = 105,8721 mg/dm^3). Different amounts of the activated carbon were added to the contaminant solution, as shown in Table 2. The four flasks were kept in constant agitation at room temperatures, and the solutions were analyzed 45 minutes after being prepared and after 3 days.

Just like in the experiments with the nanoparticles, the absorbances read were above 1,4 (the maximum value possible for the calibration curve used). Due to that, it was necessary to make dilutions (the dilution factor was 2, as the proportion was of 1:1). 0,8 ml of each Erlenmeyer flask and 0,8 ml of distilled water were placed in the quartz cuvette, which was used in spectrophotometric analysis. The concentrations of the medicine in the diluted samples, during the experiments, were determined by linear regression equation obtained by plotting the calibration curve over a range of absorbances read in the spectrophotometer (at 285 nm) and the values obtained are registered in Table 2.

Table 2. Trial registration for the activated carbon's experiments (A-absorbance; C- mass concentration (mg/dm^3))

Trial	Volume of the contaminant solution	Carbon's mass (g)	Real mass (g)	Time (45 min)		Time (3 days)	
				A	C	A	C
1	100 ml	0,05	0,050	0,644	12,69	1,173	22,94
2		0,10	0,114	0,673	13,25	0,970	19,01
3		0,15	0,150	0,671	13,20	1,145	22,4
4		0,20	0,200	0,693	13,64	1,105	21,62

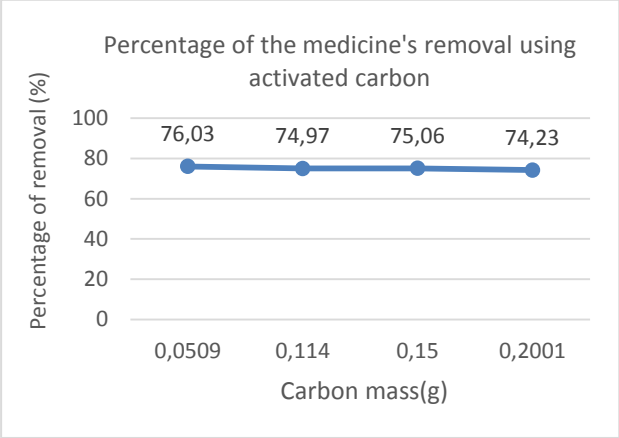

Figure 3. Percentage of the Carbamazepine's removal using activated carbon

Table 3 - Trial registration for the activated carbon's experiments (A-absorbance; C- mass concentration (mg/dm^3)

Percentage of removal (%)	Real charcoal mass (g)
76,03	0,0509
74,97	0,1140
75,06	0,1500
74,23	0,2001

The relation between the medicine's removal from the solution (calculated using Equation 2) and the carbon mass added to each Erlenmeyer flask is displayed in Figure 3 and in Table 3. However, an experimental error must have occurred, due to external factors that could not be predicted nor controlled, since in the third day after having prepared the solutions and read the absorbances in the spectrophotometer, the solutions had a brownish colour. Consequently, the values obtained in these trials were not valid and were discarded.

3. Results and discussion

Fig. 4 displays the average percentage of the Carbamazepine's removal from the prepared solution (c_m = 105,8721 mg/dm^3) using nanoparticles and activated carbon. According to the results obtained and attending to the main objective of this project, we have concluded that both activated carbon and green zero-valent iron particles are promising solutions regarding environmental remediation, namely, in terms of the removal of carbamazepine, an antiepileptic drug, from contaminated water. Despite the fact that contamination of water with this medicine occurs, mainly, in hospital environments, is it of greater importance to find innovative, efficient, and inexpensive solutions to address this issue.

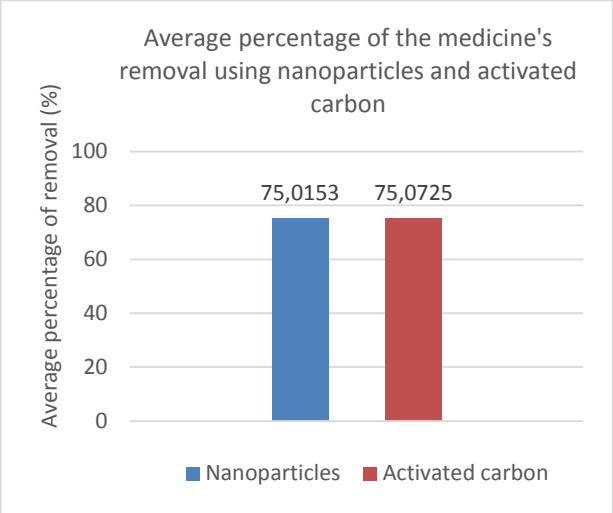

Figure 4. Average percentage of the medicine's removal using nanoparticles and activated carbon

4. Conclusion

These results reveal that both gnZVI and activated carbon can be used to remove Carbamazepine from contaminated water. Using the gnZVI, almost 80% of the medicine was removed from the solutions, by the end of 30 seconds, and we concluded that after this period of time, no significant changes were registered. Regarding the amount of gnZVI used, it was proven that amounts above 7,0 mg are not advantageous. On the other hand, using activated carbon, it becomes evident that

the percentage of the medicine's removal is, as well, close to 80%, after 45 minutes of reaction. After three days of preparing these solutions, conclusions could not be reached, due to previously mentioned factors.

5. Acknowledgments

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Determining the Opinions of Preschool Children about Science and Scientist through Short Stories

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Abstract. In this study, the views of preschool children about science and scientists were tried to be determined through short stories. Case study method was used. Participants of research consisted of 75 children aged between 48-72 months studying in five kindergartens selected from city center of Afyon, Sinanpaşa and Susuz towns. As a data collection tool, story cards were created through pictures from the book named Makara of Tübitak publications. According to study, it was determined that preschool children associate their perceptions of science and scientists with people and objects in their environment and daily life.

Keywords. Preschool, Science, Scientist, Short Story.

1. Introduction

Curiosity is one of the most distinctive features of preschool children [1]. Children have a natural tendency to explore and learn. Learning begins at a very early age and continues throughout life. Children have a great enthusiasm to learn and explore before they even start school [2]. They are in a constant state of curiosity and research to explore and learn about their environment. They ask everything, research and wonder. The experinces of children through observation and exploration offer many opportunities to them in process of perceiving, recognizing and making sense of the world. For this reason, children are often referred to as natural scientists [1].

In today's world where scientific applications are needed in every field, the importance of science is an indisputable fact. Although it is used in every field, it is sometimes very difficult for people to define what science is. While Einstein said that science is an effort to reconcile between sense data devoid of any order and regular logical thinking, according to Russell, science is an effort to find facts about the world first, and then the laws that connect these facts, through observation and reasoning based on observation [3]. Science is an activity that includes all our imaginative and emotional abilities as well as rational in process of finding truth and seeking to explain what is happening [4]. Science is the body of regular information that chooses a part of the universe or events as a subject, and tries to draw conclusions by using experimental methods and reality [5]. Science is an important part of life as every event in nature constitutes a subject of science. It is also a way of understanding and exploring the world [1]. Science is a process of examining and explaining entities and events in a field, finding generalizations and principles regarding them, and predicting future events through these principles. The reason why the concept of science is defined in such different ways is that science is constantly changing, renewing, developing, versatile and complex. Its boundaries cannot be determined exactly in terms of the events, cases and methods used [3].

In early years, children develop rapidly in terms of physical, social, emotional, cognitive and language development. Children's scientific development stems from their personal discoveries and physical and social experiences [6]. At the beginning of science education, children have innate curiosity and interest. In this way, children are starting to think about the world they live in, the properties of living things and objects and nature from a young age. However, science education is an effective method for the development of scientific thinking in children [7]. In early period, children conduct research and examination like scientists in order to understand environment they live in. Science education enables children to use their scientific process skills during their research and to develop positive attitudes towards science in this direction.

The aim of science education in preschool is to enable children to recognize events around them through their observations, to make observations, and to gain scientific process skills by using their five senses effectively. In this direction, the aims of science education in preschool are;

- To get scientific concepts,

- To develop positive attitudes towards science,
- To use appropriate scientific processes in the face of events and decisions, and to enable people working in science-related fields to think about science and technology-related events by using their knowledge, understanding and skills [6].

In order to understand science through the eyes of children, it is necessary to reveal their views on science and scientists. There are various studies conducted to determine how the concepts of science and scientist are perceived in the world and in our country [3,7-9]. In studies about scientists, a scientist is described as a person who deals with scientific studies, examines an event with scientific methods, clarifies it and presents it for the benefit of humanity. Science and scientists are presented in certain patterns in various sources such as television programs, newspapers and magazines, cartoons.

Scientists research, question, observe and question the reason for current situations besides discovering non-existent. When contemporary science and technology curricula are examined, it can be observed that an emphasis is placed on gaining these characteristics of scientists to students. In this context, students should be provided with opportunity to question what they are curious about, both by making experiments and observations in school, and by continuing their observations and experiments outside school with experience and desire they have received inside school [10].

In addition, stereotypical perceptions of students about scientists such as a lab coat, middle-aged, working alone in laboratory, asocial, bearded, wearing glasses, constantly researching, and strange are considered as negative [10]. A scientist is a universalized person who examines events and phenomena in the universe, questions them, tries to understand them, and publishes them in a way that people can understand by simplifying what they understand. S/he carries social responsibility, has high moral values, is humane, is open to criticism and self-criticism. S/he can make independent decisions, and does her/his work without any self-interest [11]. Considering scientists as individuals who research, develop, question, criticize, identify problems and seek solutions to them, one of the aims of science education is to raise children like scientists, to make them feel like scientists and to equip them with skills to use these features in problems they encounter throughout life.

As perceptions about scientists begin to form at an early age, more studies are needed on preschool children's perceptions of scientists. However, studies on pre-school children's perceptions of science and scientists are scarce [8]. With this study, both the elimination of this deficiency and the views of children towards science and scientists were tried to be examined.

2. Method

This study was designed qualitatively in order to reveal science and scientist perceptions of preschool children and case study method was used. Qualitative research provides in-depth information on describing, analyzing a situation, interpreting perceptions, behaviors and beliefs of a group or individuals [4].

Case study, as a research strategy, is used in many situations to contribute to our knowledge of individual, group, organizational, social, political and events. In study, preschool students' perceptions of science and scientists were captured through short stories. It was tried to ensure that participants could express their views without prejudice. In particular, getting the opinions of preschool children about science and scientists by asking them only through questions will not provide much data. For this reason, children's views on science and scientists were tried to be determined through short stories.

2.1. Sample of the Study

Participants of study consist of 75 children aged between 48-72 months studying in five kindergartens selected from city center of Afyon and Sinanpaşa and Susuz towns. In this study, which was carried out with the permission of school administrations before application was made, the names of participants were not used due to research ethics. Participants were coded as C1, C2, C3,...C75. 35 of them were female and 40 of them are male.

2.2. Data Collection Tools

In order to reveal children's perceptions of science and scientists, story cards through pictures from the book named Makara of Tübitak publications were created as a data collection tool. The author of book is Gerry Bailey. The original language of book is English. The translator of book is Nihal Demirkol Azak. The story book was published by Tübitak Publications in Ankara in February 2016. The size of book is 25×23 cm. The heroes of book are Robo and Robi.

In book, robots explore benefits of reel and its usage in our daily lives. Since the book contains themes about science and scientist perceptions of preschool children, this story was chosen by means of expert opinion. The pictures of book were turned into enlarged story cards in order to attract children's attention. Picture story cards prepared by researchers were read collectively to preschool children.

The questions about story were asked to children individually. It took 15-20 minutes to read the story and to get answers. Obtained data were noted. In study, flexibility was tried to be made in questions, taking into account the developmental characteristics of children. 8 different questions asked to children:

1. What is the name of our story?
2. Who are the heroes in our story?
3. What did Robo and Robi want to do?
4. What kind of challenge did Robo and Robi face?
5. What did they do to overcome the challenge?
6. What do you call a person who produces something like a machine?
7. Who is a scientist? What comes to mind when you think of a scientist?
8. What comes to your mind when you think of science?

The first and second questions were about story. The third, fourth, fifth and eighth questions were about determining the expectations about science. The sixth and seventh questions were asked to reveal the perceptions about scientists.

2.3. Analysis of Data

In study, descriptive analysis was used. Data obtained from children in accordance with questions asked to children are coded. In a qualitative research, direct quotations will contribute to the understanding of social events, as this will enable in-depth discovery of the subject.

3. Findings

After short story was read to reveal the perception of science and scientists of preschool children, 8 questions were asked to children. Their answers, frequencies and percentages are given in tables below.

Table 1. Answers about "What is the name of our story?

Answers	Frequencies (f)	Percent. (%)
Makara	29	21,75
Robo and Robi	18	13,50
Makara and Robi	9	6,75
Makara robot	6	4,50
Robot	6	4,50
Robot Toti	2	1,50
Non-responders	5	3,75

Table 2. Answers about "Who are the heroes in our story?"

Answers	Frequencies (f)	Percent. (%)
Robo and Robi	45	33,75
Robot(s)	8	6
Robo	7	5,25
Makara and Robot	7	5,25
Makara and Robi	2	1,50
Makara	2	1,50
Robot Toti	2	1,50
Rope	1	0,75
Robi	1	0,75

The answer of question "What is the name of our story?" is "Makara". While 21.75% of 75 children answered as Makara, 18 (13.50%) answered as Robo and Robi. 29 children knew the answer correctly as "Makara", remaining children could not give a correct answer. 5 children did not answer the question.

The correct answer of question "Who are the heroes in our story?" is "Robo and Robi". While 33.75% of children gave correct answer, 'Robot(s) (6%), Robo (5,25%), Robi (0,75%)' were determined as acceptable answers. Children who gave these answers constitute 12% of total. Remaining children did not give the expected answer to question.

The answers of question "What did Robo and Robi want to do?" vary greatly. The correct

answer can be expressed as 'Robo and Robi want to remove the old engine of the car and add a new engine in its place.'. Answers given by children could be listed as removing engine, adding a new engine, trying to repair, repairing car, pulling engine.

Table 3. Answers about "What did Robo and Robi want to do?"

Answers	Frequencies (f)	Percent. (%)
Fixing cars	12	9
Lifting cars	8	6
Driving cars	7	5,25
Producing cars	5	3,75
Buying cars	3	2,25
Removing engine	3	2,25
Inventing	3	2,25
Pulling engine	3	2,25
Adding another engine	2	1,50
Running a car	2	1,50
Making a reel	2	1,50
Producing engine	2	1,50
They pulled engine and wanted to drive.	2	1,50
Producing helicopter	1	0,75
Producing machine	1	0,75
Producing an old car	1	0,75
Truck	1	0,75
Anything	1	0,75
Trying to repair	1	0,75
Taking out the car	1	0,75
Pulling out the car	1	0,75
Driving car and lifting	1	0,75
Non-responders	12	9

The answer of question "What kind of challenge did Robo and Robi face?" is "They could not lift the old heavy engine of the car". %18 of children gave correct answer. Correct acceptable answers were determined as they could not remove engine, they could not pull engine, the reel was not enough. These answers correspond to 5.25% of children. 69.25% did not give desired answer to question. 2.25% of children gave answers independent of story. However, it turned out that they did not understand story. In question 4, the purpose is to reveal science-based questions, on the other hand, children perceived the hero in story as the person who made repairs. Desired results related to science could not be achieved.

The answer of question "What did they do to overcome the challenge?" is "Reel". 36.75% of the children gave correct answers. 3% of children gave completely independent answers with answers of "lever, rod, hammer and anything". 55.75% gave appropriate and acceptable answers. Question 5 reveals children's perceptions about science. In the answers given by the children, it was determined that they perceived the concept of science appropriate to the story.

Table 4. Answers about 'What kind of challenge did Robo and Robi face?'

Answers	Frequencies (f)	Percent. (%)
They were forced.	18	13,50
Engine was too heavy.	15	11,25
They couldn't lift engine.	9	6,75
They didn't remove engine.	4	3
They used reel.	3	2,25
They made two reels.	2	1,50
The engine of car did not start.	2	1,50
S/he wanted to fix the car.	1	0,75
S/he added a string, it didn't work.	1	0,75
S/he carries car inside.	1	0,75
Car broken	1	0,75
The car couldn't lift.	1	0,75
Not a single wheel lifted.	1	0,75
S/he pulled the engine.	1	0,75
The reel was not enough.	1	0,75
They were not forced.	1	0,75
S/he lifted the engine.	1	0,75
S/he tried to build a car engine.	1	0,75
S/he couldn't pull the car.	1	0,75
Non-responders	10	7,50

Table 5. Answers about 'What did they do to overcome the challenge?'

Answers	Frequencies (f)	Percent. (%)
Reel	49	36,75
S/he added two reels.	4	3
Rope/Two ropes	3	2,25
It was pulled.	3	2,25
S/he adds two wheels. S/he puts on another reel.	2	1,50
S/he produces engine.	2	1,50
Lever	1	0,75
Hammer	1	0,75
Rod	1	0,75
Wheel	1	0,75
Anything	1	0,75
Lifting high	1	0,75
Non-responders	6	4,50

Table 6. Answers about 'What do you call a person who produces something like a machine?'

Answers	Frequencies (f)	Percent. (%)
Mechanic	14	10,50
Invertor	9	6,75
Master / Worker	8	6
Scientist	7	5,25
Fixing	4	3
Machinist	3	2,25
Producing car.	3	2,25
Builder	2	1,50
Professor	2	1,50
Key-maker	2	1,50
Sculptor	1	0,75
Trasta	1	0,75
Working uncle	1	0,75
S/he invents.	1	0,75
Archaeologist	1	0,75
Reeler	1	0,75
Non-responders	15	11,25

Table 7. 'Who is a scientist? What comes to mind when you think of a scientist?'

Answers	Frequencies (f)	Percent. (%)
Do experiments.	6	4,50
Mechanic	5	3,75
Produce cars, ships and toys.	4	3
Inventor	4	3
Potion Mixer	3	2,25
Produce engine.	3	2,25
Discover new things.	3	2,25
Fix.	3	2,25
Produce robots.	3	2,25
Produce tables.	1	0,75
Know everything.	1	0,75
Remove obsolete engines.	1	0,75
Produce machine.	1	0,75
Remove engines.	1	0,75
Produce reels.	1	0,75
Repair old goods.	1	0,75
Produce dolls.	1	0,75
Build buildings.	1	0,75
Produce different things.	1	0,75
Cleaner	1	0,75
Live as we live.	1	0,75
Truck	1	0,75
Robot	1	0,75
Telephone	1	0,75
I don't know.	1	0,75
Run the car.	1	0,75
Television	1	0,75
Science	1	0,75
Demonstrate science.	1	0,75
Detective	1	0,75
Do exercise.	1	0,75
Search gold.	1	0,75
Non-responders	17	12,75

Table 8. Answers about 'What comes to your mind when you think of science?'

Answers	Frequencies (f)	Percent. (%)
Light	4	3
Produce cars.	3	2,25
Discover new things.	3	2,25
Inventor	3	2,25
Fixing	2	1,50
Machine	2	1,50
Invention	2	1,50
Make new things.	2	1,50
Scientist	2	1,50
Know everything.	2	1,50
Sharing	2	1,50
Talented	1	0,75
Learn.	1	0,75
Study.	1	0,75
Help.	1	0,75
Save a life.	1	0,75
Astronaut	1	0,75
Tractor	1	0,75
Wheel	1	0,75
Make table.	1	0,75
Produce engine.	1	0,75
Electricity	1	0,75
Gold sun	1	0,75
Think.	1	0,75
Lamp	1	0,75
Movie	1	0,75
Do experiment.	1	0,75
Draw picture.	1	0,75
Play game.	1	0,75
Produce computer.	1	0,75
Produce guns.	1	0,75
Something comes to mind when we think about it. S/he does it.	1	0,75
Non-responders	27	20,50

The answer of question "What do you call a person who produces something like a machine?" is "scientist and inventor". 12% of children gave the answer of inventor and scientist. The professor answer was determined as the closest answer. This constitutes 1.5% slice of answer. 3% of them answered that they make a reel and car by connecting with story. The rest of the children gave answers by adapting the concept of scientist to their daily life. These corresponds to 72.25% of answers. As it can be understood from here, children used the concept of scientist as people they see around and in their daily life. 11.25% of children did not want to answer this question.

The correct answers of question are experiments, inventor, discovering and knowing new things, producing different things, science,

being scientific, making robots. 17.25% of children answered this question correctly. While 15.75% of them gave answers related to story, 54.25% of them gave answers not related to story. In question 7, the views of children on concept of scientists were sought. A large part of children, such as 54.25% could not perceive the concept of scientist. 33% of them were able to perceive the concept of scientist.

Since question "What comes to mind when you think of science?" is an open-ended question, 19.25% of children gave answers that could be correct. While 6.75% gave answers depending on story, 53.50% gave answers independent from story. This question was asked in order to determine the concept of science. Since it is an open-ended question, the answers given by children can be accepted as correct.

4. Conclusion and Discussion

In this study, the views of preschool children on science and scientists were examined and answers given by children were evaluated through the short story tool. When literature about children's thoughts about science and scientists is researched, there are not many studies for preschool children to determine their thoughts about science and scientists. On the other hand, it can be said that most studies conducted for this aim are for students at different learning levels, teachers/teacher candidates by drawing pictures, interviews and questionnaires. There are various studies conducted to determine how the concepts of science and scientist are perceived in the world and in our country [3,5,7,9,12-14].

In this study, the perceptions of pre-school children aged 48-72 months about science and scientists are included. A short story about science and scientist was read to children and questions were asked after the story read. The questions were asked individually. 15.75% of children gave acceptable answers to question "What did Robo and Robi want to do?". While 18% of respondents answered question "What kind of challenges did Robo and Robi face?" correctly, 5.25% were determined as acceptable. 36.75% of them gave correct answers to question of "What did they do to overcome the challenge?", 55.75% gave acceptable answers. When distribution of the answers to question “What is science?” is examined, it is seen that the majority of them answered as "I don't know" or they did not answer at all. Other kids seem to describe science as knowing everything, formulas, compounds, potions, technology and inventions, experimenting, researching and studying, the job of spacemen, engineers, doctors, and professors [8].

On the other hand, it was determined that 72.25% of children gave examples about scientists concept mostly from their environment and daily life. 17.25% of their answers about “Who is a scientist?, What comes to mind when you think of a scientist?” were accepted as correct. It was determined that 5.75% were related to story. In this study, preschool children's perceptions of scientists were defined with expressions such as a man who makes a robot, invents, produces a car, does experiments, mixes potions, discovers something new and knows. To preschoolers, scientists are often people who build robots, invent, research and create mixes, with or without short hair, aprons and glasses [4]. In a study conducted with primary school students, it is seen that scientists are people who just invent [14].

According to study, it can be said that preschool children's perceptions of science and scientists are mostly associated with their environment, people and objects from their daily life. When science was mentioned to children, different concepts such as light (3%), electricity (0.75%), lamp (0.75%), machine (1.50%), repair (1.50%), table maker (0.75%), wheel (0.75%), electricity (0.75%) were perceived. When scientist was mentioned, concepts such as a mechanic (3.75%), a car maker (3%), a table maker (0.75%), a cleaner (0.75%), a builder (0.75%), an activity (0.75%) were understood. This shows that they perceive concepts differently. As stated above, they gave examples from their daily lives.

According to the results obtained from study, activities on science and scientists should be given more in order to create perceptions about science and scientists in preschool education. These can include activities which are compatible with real life, which can make children feel more like scientists. Various studies can be carried out with other types of activities in preschool for educators to realize the concept of science and scientist in children.

It may be necessary to include family participation in the studies conducted on science and scientists for preschool children, and educators can conduct family participation studies with families so that families can improve themselves about the concept of science and scientist.

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Augmented Reality Applications in Preschool Science Education

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Abstract. The aim of study was to conduct the effect of using augmented reality applications in preschool science education on the scientific process skills of 5-6 year old children. A pretest-posttest single-group quasi-experimental design was used. Scientific Process Skills Test, researcher observation form and participant interview form were used as data collection tools. According to the findings of the study, there was a positive significant increase in children's scientific process skills. According to researcher observations and student interview results, students participated in the activities willingly and enthusiastically. It was observed that their interest in science activities increased.

Keywords. Augmented Reality, Preschool Science Education, Scientific Process Skills.

1. Introduction

With the birth of child, basic scientific process skills begin to develop [4], and stimulants in nature such as colors, lights, sounds and tastes begin to attract the attention of the child [1]. It can be seen from the age of two that children begin to exhibit classification skills by bringing together similar ones from different objects [3]. Through preschool science education, children can be helped to comprehend and see the unknown in their environment by using their natural research and curiosity, and it can also contribute significantly to children's psychomotor, emotional, social and cognitive development [15]. Science education is an educational process in which individuals are taught the ways of accessing and using information, enabling them to use scientific methods and techniques to solve the problems they encounter in their daily lives, suggesting rational solutions to the problems they encounter, and gaining the skills to adapt to both natural environment and social environment more easily [23].

Thanks to environmental experiences that will be presented in preschool period, children can realize the interaction of people, plants, animals, water, soil, sun, air, in short, everything in nature [15]. Technology can be used in cases where children cannot experience environment due to reasons such as climate and economic inadequacy of region where educational institutions are located. Digital learning experiences have become increasingly accessible thanks to technological devices such as smartphones and tablets [19]. Rather than discussing whether technology will be used in education, it would be more appropriate to discuss how to use technology in education. The use of technology is a necessity in terms of increasing the quality of education and contributing to the development of children of all ages [8].

The widespread use of technological tools in education process, especially in pre-school period, draws the attention of children visually and audibly, and it is stated that technology applications have effects on different development areas of children [27]. The use of mobile technologies, on the other hand, provides advantages in terms of being economical, being portable anywhere, and being usable at any time and in any environment [10]. By adding images, data and other content to the real world through augmented reality applications that can be used through mobile technologies, virtual reality and real world elements can be combined in the same environment [13].

In augmented reality, which is a different form of virtual reality, users perceive real and virtual objects together in the same environment [6]. Augmented reality applications not only attract the attention of students, but also increase their participation and motivation, and help them develop different perspectives [17]. Augmented reality applications help students learn experiments that are difficult to do in the real world, and subjects that are complex to explain, in terms of providing a realistic simulation environment [22]. Augmented reality applications have turned into an effective tool that can be used in educational environments thanks to their educational potential [7].

In augmented reality, users are in contact with the real world. In this respect, augmented

reality differs from virtual reality application [28]. Virtual reality gives the feeling of being in a real environment in the minds of constructions with technological tools of 3D pictures or animations created in the computer environment [11]. In augmented reality, a real-time and interactive environment is created by adding virtual/artificial information to the physical world. This environment is formed in both spatial and temporal contexts [10]. Augmented reality differs from virtual reality in that users interact with the real world without any attempt to change the real world [2].

Scientific process skills can also be defined as asking questions about problems encountered in daily life, recognizing and controlling variables, and drawing conclusions by forming hypotheses [18]. In pre-school science activities, it is expected that children will actively participate in experiments, gain skills such as making observations, comparing, classifying, and establishing cause-effect relationships [5]. It is thought that the use of augmented reality applications [22], which enables students to learn experiments that are difficult to do in real world and subjects that are complicated to explain, in terms of providing a realistic simulation environment, may have an impact on scientific process skills of preschool children. The aim of this research is to determine the effect of using augmented reality applications in science activities in the education of preschool children on children's scientific process skills.

2. Method

In this study, quasi-experimental design, one of the quantitative research methods, was used. Although semi-experimental design comes after full experimental models in terms of scientific value, it can be considered as the best that can be found in the current environment [16]. In quasi-experimental design, independent variable is the application to experimental group during the experiment. After pre-test application, experimental group was given augmented reality cards called “giant dinosaurs, our solar system, animals, skeleton, organs, I eat healthy, vehicles” via mobile devices during science activities. In augmented reality applications, besides the language development gains, family participation is also included. Children were also given opportunity to use augmented reality education cards individually. Thus, all students in the experimental group were provided to experience these cards. Before and after the use of augmented reality cards, the Scientific Process Skills Test (SPST) was applied. The research was conducted with 18 children, 10 female and 8 make, in the 5-6 age group attending a kindergarten located in Afyonkarahisar.

3. Data collection tools

Teacher observations, semi-structured interviews with students and the Scientific Process Skill Test (SPST) [4] was used to obtain research data. SPST consists of 24 questions and is applied by marking the answers given by students to the questions read by researcher. After it was determined that data obtained from SPST were suitable for parametric tests, it was tested whether there was a significant difference between the BSST pre-test and post-test scores via the paired sample t-test. In order to determine whether there is a significant difference in SPST pre-test and post-test scores in terms of gender, independent samples t-test was performed. Data obtained from the interviews with students and researcher observations were analyzed by descriptive analysis.

4. Results

In this study, data which was analyzed with the paired sample t-test and the findings are given in Table 1.

Table 1. Comparison of SPST pre test and post test Scores with the paired sample t-Test

	N	X	Standart Deviation	Standart Error	Sd	t	p
Pre test	18	43.7222	6.59595	1.55468	7.79811	-9.189	.000*
Post test	18	60.6111	4.48709	1.05762			

*(p<.05)

When SPST pre-test and post-test scores of children were compared with the t-test, it was observed that there was a significant difference (p=.000, p<.05). When pre-test averages (X=43.7222) and post-test averages (X=60.6111) of children before performing science activities with augmented reality cards were examined, it was observed that there was a significant increase.

Table 2 shows independent samples t-test findings, which were conducted to determine whether the SPST pre-test averages of the children who participated in the study differed in terms of gender variable.

Table 2. Comparison of SPST pre test scores in terms of gender

Gender	N	X	SS	t	p
Female	10	44.10	6.04520	.264	.795*
Male	8	43.25	7.62983		

* p>.05

According to independent samples t-test findings, SPST pre-test averages of female (N=10) and male (N=8) students do not differ in terms of gender (p=.795, p>.05).

Table 3 shows the independent samples t-test findings, which were conducted to determine whether the SPST post-test averages of the children participating in the study differed in terms of gender variable.

Table 3. Gender Comparison of SPST Posttest Scores

Gender	N	X	SS	t	p
Female	10	59.80	3.96653	-.850	.408*
Male	8	61.62	5.15302		

* p>.05

According to independent samples t-test findings, SPST post-test averages of female and male students do not differ in terms of gender (p=.408, p>.05).

As a result of the analysis of researcher observation forms, the observations regarding the experiences and feelings of children during activities are given in Table 4.

According to Table 4, students are willing to participate in activities and activities attracted their attention. It was observed that students had difficulties in activities that they had no prior knowledge of. The answers given to student interview forms are coded with key words and given in Table 5.

Table 4. Observations in Children During the Activities

	Willingness	Excitement	Happiness	Attract attention	Have prior knowledge	Strain	Fun
We eat healthy	X		X	X	X		
Vehicles	X		X	X			X
Giant dinosaurs	X		X	X	X		X
Solar system		X	X	X		X	
Animals	X			X	X		
Skeleton	X	X		X		X	
Our organs	X			X		X	
TOTAL (f)	6	2	4	7	3	3	2

Table 5. Student Interview Form Findings

Interview Questions	Codes of Student Responses
What did you like to review at the events?	Vehicles (f=4), Skeleton (f=2), Dinosaurs (f=2), Organs (f=2), Planets (f=1), Animals (f=1)
What features do you think should be added to augmented reality cards?	Sound (f=3), Motion (f=1), Beauty (f=1)
Where do you see what you see on augmented reality cards in your daily life?	In my daily life (f=4), on TV (f=1)

According to Table 5, students see what they see on augmented reality cards in their immediate surroundings. One of the students' answers was “I see cats and dogs on the street. I see cars on the roads. In the sky, I see the sun and the moon”.

When asked what kind of features they recommend to be added to augmented reality cards, the answers of students most frequently are "If sound is added, the skeleton can answer us", "I would like what I see on the cards to talk to us".

5. Discussion and conclusion

In this study, in which the effect of augmented reality cards applications on Science Process Skills was investigated, science activities were organized by using augmented reality cards. According to the results of study, in which 18 children in the 5-6 age group participated, there was a positive significant difference between the children's SPST pretest and posttest scores. Augmented reality applications, in terms of providing a realistic simulation environment, can enable students to learn experiments that are difficult to do in the real world, and learn complex subjects [22] and increase students' participation and motivation, thereby enabling them to develop different perspectives [17]. Augmented reality cards, which have attracted the attention of children, can also be used in other science activities in order to increase their science process skills.

It was determined that there was no significant difference in SPST scores in terms of gender variable. Thanks to the attitudes of teachers and the teaching techniques they use, solid scientific foundations can be formed in children [25]. Augmented reality applications increase students' cognitive skills such as comprehension and retention [9]. Augmented reality application not only increases the success of preschool children in learning English vocabulary, but also increases their desire to learn [12]. Regardless of the gender variable, the use of augmented reality applications can be applied in other science activities and learning areas.

As a result of the research, it was seen that the students were eager, excited and happy to participate in the activities. It has been stated that the learning environment will become constructivist, participatory, collaborative, creative, authentic, fun and motivating with the use of augmented reality [14]. It has been observed that augmented reality applications are liked by children in teaching basic concepts such as animals, plants, professions, colors, numbers and shapes to 33 children in the 5-6 age group [26]. It has been seen that augmented reality applications in teaching numbers to children increase the interest in the lesson and make the lesson fun [24]. The use of augmented reality applications in teaching letters has increased the motivation of children [20].

Preschool education in Turkey covers children between 36-72 months. Educational environments should include blocks, books, music, art, drama and science learning centers. With the activities held in the science center, it is aimed to stimulate children's sense of curiosity and learning desire, and it is aimed to improve the scientific process skills of children by learning new things about the world [29]. It can be said that both pre-service teachers and on-duty teachers should be informed about the use of augmented reality floors, which is an activity that can be applied in cases where real learning environments cannot be created or the physical facilities of schools are insufficient. By carrying out this study in various settlements, research findings can be developed in terms of the size and possibilities of the settlement.

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The Effect of STEM Activities on Preschool Children's Basic Process Skills

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Abstract. The aim of study was to determine the effect of STEM activities on preschool children's basic process skills. A quasi-experimental design with pretest-posttest control group was used. Basic Process Skills Test, researcher observation form and participant interview form were used as data collection tool. According to the findings of the study, it was determined that the scores of the experimental group differed significantly in favor of the experimental group compared to the scores of the control group. According to researcher observations and student interview results, it was seen that students were eager and curious to participate in STEM activities.

Keywords. Basic Process Skills, Preschool Children, STEM.

1. Introduction

Preschool education process, which starts at the age of three, is the first stage of systematic education process, as well as preparation process for basic education [25]. The rate of learning in the preschool period, which can be defined as the basis of life, is quite high [26]. A child, who interacts with his/her environment through pre-school science education, will realize lifelong cognitive and affective structures in his/her mind against science and nature [27]. Considering that the mental development of children is completed in preschool period, educational opportunities and activities to be provided in this period are important [5].

Children's interest in science starts at a young age [24]. Considering development in children's perception of scientific concepts and other developmental areas of children, science education should begin in the preschool period [19]. Preschool children like to make observations about nature and can make scientific inferences and understand scientific concepts [14]. Therefore, education to be given to children in this period should be of a quality that will contribute to the level of knowledge [6]. In preschool science education, activities that will ensure the mental development of children and educational opportunities should be provided.

STEM education is an interdisciplinary approach that covers the entire educational process from preschool to higher education. As a developing field, engineering education has many features of a discipline that has undergone a scientific revolution [8]. The term STEM refers to teaching and learning in the fields of Science, Technology, Engineering, and Mathematics [15]. STEM education should offer more engineering during preschool. Considering the economic importance of engineering for society, students should learn about engineering and develop some skills and abilities related to the design process [10].

Science activities in preschool curriculum should be planned in a way that will enable children to make sense of science and associate it with daily life [13]. It is possible for children to gain the ability to solve problems in daily life with the development of scientific process skills [22]. Scientific process skills form the basis of science as they develop a basic understanding of scientific process in children [2] as well as the ability to question and reach research results [23]. It is thought that STEM education is related to the development of basic process skills of individuals in terms of the importance [20] that preschool education has in terms of raising children as individuals who can research, solve problems and become entrepreneurs. In this study, it was aimed to determine the effect of STEM activities on the Basic Process Skills of preschool children.

2. Method

The research was designed with a quasi-experimental design with pretest-posttest control group, which is one of the quantitative research methods. In the pretest-posttest control group model, one of the two groups formed by unbiased assignment is used as the experimental group and the other as the control group [21]. This research was carried out with 30 preschool students aged 60-72 months in Afyonkarahisar. 15 of the 30 students were in the experimental group and 15 of them were in the control group. As a result of the pre-test applied to experimental group and control group, it was seen that the mean scores of groups were very close to each other. STEM activities were applied to 15 students in the experimental group for 10 days. As one activity each day, the activities named "I Know My Friend, Sea, Air and Land, Butterfly, Boxes, Chickpeas with Toothpicks, Dinosaur, Egg, Swimming-Stinging, Pickle" were implemented.

3. Data collection tools

Before and after implementation of STEM activities, the Basic Process Skills Scale (BPSS) which was developed by [6] was applied. The basic process skills scale consists of 20 questions about observation, classification, inference, measurement and estimation skills. The reliability coefficient of scale (KR-20) is.74, and the mean difficulty is.69. Data obtained from scale were analyzed with a computer program. Independent samples t-test was conducted to compare the scores of the experimental group and the control group obtained from the scale and to compare the pretest-posttest scores. Researcher observations and student interview forms were analyzed by descriptive analysis.

4. Results

Table 1 shows the independent samples t-test findings, which were conducted to determine whether there was a difference in the BPSS scores of experimental group students and control group students before the implementation of STEM activities.

According to the independent samples t-test results, it was determined that there was no significant difference in the BPSS pre-test scores of experimental group (X=14.73) and control group (X=15.76) (p=.116, p>.05).

Table 1. t-Test Results of BPSS Pretest Scores

Group	N	X	SS	t	p
Experimental	15	14.73	1.79	-1.424	.166*
Control	15	15.76	1.80		

*p>0.05

After the implementation of STEM activities, independent samples t-test findings, which were conducted to determine whether there was a difference in the BPSS scores of the experimental group students and the control group students, are given in Table 2.

Table 2. t-Test Results of BPSS Post-Test Scores

Group	N	X	SS	t	p
Experimental	15	19.20	.56	10.64	.000*
Control	15	15.33	1.29		

*p<.05

When the BPSS post-test scores of experimental group and control group were compared, it was observed that there was a significant difference in favor of experimental group (p=.00, p<.05). In addition, when the BPSS pre-test scores of experimental group (X=14.73) and the BPSS post-test scores (X=19.20) were compared, it was determined that there was an increase of 30.34% in favor of experimental group in the post-test. The results of researcher observation forms are given in Table 3.

According to Table 3, students in experimental group were willing to participate in the activities and showed creativity features. The activities attracted the attention of children and they had fun. When the activities that the students had difficulty in were examined, it was seen that they were activities that required motor skills.

The answers given to the student interview forms are coded with key words and given in Table 4.

According to Table 4, when the activities that experimental group students had difficulty in were examined, it was seen that common features of these activities were related to motor skills. Motor skills should be used in swimming & sinking, chickpea, fabric dyeing activities and cutting & pasting activities.

When asked "what they learned from the activities", some of the students in experimental

group stated that they learned information about animals. Examples from answers were as follows: "I learned where animals live", "I learned about the transformation of a butterfly", "I learned about extinct animals".

Table 3. Observations in Children During the Activities

	Intrigued	Willing to participate	Had fun	Liked	Surprised	Have prior knowledge	Creativity	Forced
I Know My Friend	X	X		X				
Sea		X					X	
Air and Land			X	X		X		
Butterfly			X			X		
Boxes		X		X			X	
Chickpeas with Toothpicks			X				X	X
Dinosaur	X	X	X		X			
Egg	X	X					X	X
Swimming-Stinging		X					X	X
Pickle	X		X				X	
TOTAL (f)	4	6	5	3	1	2	6	3

Table 4. Student Interview Form Findings

Interview Questions	Codes of Student Responses
In which activities or in which situations did you find it difficult?	Gluing and cutting (f=2), Butterfly activity (f=2), Dinosaur activity (f=2), Chickpea activity (f=1), Swimming and sinking activity (f=1), Fabric dyeing (f=1), I was not forced (f=1)
What did you learn from the events?	Animal Knowledge (f=8), Dyeing Fabric with Fruit Juice (f=1), Making Objects with Chickpeas (f=1)
If dinosaurs had lived today, what would we have done for them?	We should feed it (f=5), Nest (f=2), We should put it in the zoo (f=1), Car (f=1), No answer (f=1)
What kind of product would you make to clean our polluted world?	Garbage Picker (f=4), Broom (f=3), Giant Garbage Truck (f=2), Trash Can (f=1)

When asked “If the dinosaurs lived today, what should be done for them”, some of the students in experimental group most frequently gave answer "We should feed them", "We need to give things like meat", "We need to build a nest for them", "If Tireks lives, we must give him a lot of meat".

When asked “what kind of product they would like to make to clean our polluted World”, the answers of students in experimental group were as follows: "I would make a giant garbage truck", "I would make a garbage picker", "I would make a broom".

When the researcher observation forms were examined, it was seen that experimental group students were very willing to participate in the activities, exhibited creativity and had difficulties in some activities. In addition, it was observed that the experimental group students were curious about the next STEM activities and were interested in science fields. The data obtained from the student interview forms and the data obtained from the researcher observations overlap with each other.

5. Discussion and Conclusion

After the implementation of STEM activities in study, it was observed that the BPSS scores of experimental group differed significantly from the scores of control group. In order to support the development of children in this direction, appropriate educational opportunities should be provided so that they can conduct research, establish cause-effect relationships and produce innovative ideas, and educational environments should be arranged accordingly [3]. However, it was observed that studies in which children were less active due to teachers' lack of equipment were included [11]. In addition, it was observed that teachers neglected science activities in their classrooms due to their lack of knowledge in the field of science [18], and that some science activities could not be applied adequately due to material problems [17]. In addition to the lack of knowledge, it has been observed that teachers also encounter problems such as inadequacies in the educational environment and excess classroom sizes [7]. Considering the positive effects of the implementation of STEM activities on the development of basic process skills and scientific process skills in preschool, it can be said that teachers should be adequately equipped about STEM, scientific process skills, basic process skills and science, and thus they can provide adequate science education in their classrooms.

In study, it was observed that there was a significant difference between the BPSS pretest scores and the posttest scores of the experimental group to whom STEM activities were applied, and an increase of 30.34% in the level of scientific process skills occurred in the posttest scores compared to the pretest scores. It is very important to ensure the development of children's research, examination and observation skills and thus to support them to form a scientific basis [16]. However, it has been observed that teachers care more about literacy preparation activities in the preschool period, and the underlying reason is the expectations of the students' families [4]. Considering the fact that being innovative, creative thinking, and being able to think interdisciplinary are life-long skills, just as literacy skills are necessary throughout life, it can be said that students' families should be informed about this issue and enough time should be spared for science activities.

It was observed that students who participated in this research were willing to participate in STEM activities, exhibited creativity and were interested in science. Thanks to science education in the preschool period, it is possible to develop children's sense of curiosity and research and to stimulate their mental abilities [3]. In order for Turkey to make progress just like other countries, it is necessary to raise an innovative, entrepreneurial and creative generation who is interested in STEM fields in schools [1]. Children who encounter science fields at an early age will be able to better understand scientific concepts in their education levels in the following years [14]. Science education in the preschool period has an important place in arousing the naturally existing sense of curiosity in children [9].

It has been observed that children who had a lot of fun during STEM activities, wanted to participate in the activities and exhibited creativity had difficulties in activities that required motor skills. In order for students to acquire basic science concepts effectively, the methods and techniques that teachers will apply during the lesson should be suitable for the developmental level of the children [12]. In this respect, it can be said that teachers should design activities taking into account the developmental levels of students.

When the interview forms made with the experimental group students were examined, it was seen that the students had difficulties in activities that required motor skills, as in the researcher's observations. On the other hand, instead of giving up in the activities they had difficulty with, the students showed creativity and were willing to participate in the activities. In this respect, it was seen that the findings obtained from the researcher observation forms and the student interview forms overlapped with each other. A science corner is established in preschool education institutions in Turkey. It has been observed that preschool teachers love the field of science education, are interested and believe in its necessity [7]. In order to prevent teachers from neglecting science education due to their lack of knowledge [18], although they love and care about science education, it can be recommended to make plans for pre-service teachers to experience STEM activities practically. It can be suggested that teachers on duty should also be educated about science process skills, basic process skills and STEM through in-service training.

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The View of Secondary School Students on Using Digital Stories in Social Sciences

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Abstract. In this present study, it is aimed to reveal the opinions of the students, who attended the Social Science Courses supported by the digital stories created by the students, on the use of educational stories for educational purposes. The study was conducted as a case study, one of the qualitative studies. The study group was determined by using purposeful sampling method and consisted of 15 students from the 5th grade in 2020-2021 academic year. The data were collected by using 'Students' Diaries'. The data were analyzed by using qualitative analysis methods. The findings showed that using digital stories prepared by the students in the classroom makes the lesson more interesting and helps to take the students' interest. It is also reached that the digital stories help the students remember the subjects better by supporting peer-learning. The results of the study also reveal that the digital stories help the students to develop the freedom of speech and feel empathy with others.

Keywords. Digital Story, Secondary School, Social Sciences.

1. Introduction

With the popularity of information technologies and the rapid increase in global knowledge, most researchers working in the field of education have begun to focus more on education and training activities supported by technology. Researchers have tried to develop various computer-aided systems, strategies and materials that will contribute to the improvement of students' learning performance [1-2]. Digital stories are a method that has emerged for this purpose and has recently become popular in the field of education and combines classical storytelling and technology. The term digital story, which was first used by Dana Atchley and Joe Lambert, who saw the potential of computer and multimedia use in the educational environment in the early 90s [3], is defined by some researchers simply as storytelling with the use of digital devices [4-5]. The digital story emerges as a unique element that can be used by individuals to address themselves and to help them create unique works. Since ancient times, human beings have tended to describe their experiences visually with the pictures they drew, orally with the stories they told, and in writing with the texts they wrote. The digital story, on the other hand, these forms that have been used throughout history.

Along with the developments in our age, the stories that are traditionally used in education have been digitalized by keeping up with the needs of the age. As a result, digital storytelling has quickly become popular as a powerful learning tool in the educational context [6-8]. The main reason for this rapid popularity is that digital stories are an almost appropriate pedagogical tool in education for all ages and grades [9].

Digital stories help students discover the meaning of their own experience, value it and transfer the experience to others at different levels [10]. Students, who have the opportunity to share their work with their peers thanks to digital stories, will be able to increase their achievements in emotional intelligence, cooperation and social learning, and gain valuable experience in criticizing their own and other students' work.

In this context, the purpose of this study is to determine the view of secondary school students on using digital stories in the social sciences.

2. Method

In this study, it is aimed to determine the views of students on the use of digital stories in the educational environment. For this reason, case study, one of the qualitative research designs, was used in this study.

3. Study Group

The study group of the research was determined by purposive sampling method in order to conduct in-depth research and to reach data-rich situations in accordance with the research problem. It was carried out with 15 fifth grade students (9 Female; 6 Male) at

Erenler Secondary School in Afyonkarahisar City Center, Turkey.

4. Data Collection Tools

In the study, student diaries were used to reveal what the students experienced during the study.

5. Data Analysis

The data collected in this study were coded in accordance with the themes and codes through content analysis, one of the qualitative data analysis methods.

Table 1. The Codes and the subthemes under the student theme

Theme	Subtheme	Code	*f*
Student	**Attendence**	Increasing student interest	14
		Arouse curiosity	1
	Affective Fields	Student motivation	2
		Transferring Emotion	2
		Increasing student self-confidence	1
		Sense of success	1
	Value Learning	Positive contribution to value learning	8
		Developing multiple perspectives	5
		Peer Learning	5
		Awareness raising	3
	Skills Learning	Research skills	5
		Developing digital skills	5

5.1. Study Process

During the study, seven weeks, the digital stories created by the students on the social values, respect, responsibility, savings, scientificness, natural environments, freedom and heritage, were used as materials and watched. After each session, the students were directed to discuss on the digital stories then they were asked to write their experiences on their diaries.

5.2. Findings

The data from the diaries revealed three themes as 'Student, Application Process, Negative Aspects'. The sub-themes and the codes under the Student theme is given in Table 1. The sub-themes and the codes under the Application Process themea are given in Table 2.

Table 2. The Codes and the subthemes under the application process theme

Themes	Subthemes	Code	*F*
Application Process	**Classroom Env.&Man.**	Fun in lessons	7
		Freedom of expression	3
	Adaptedness	Real-life relativity	3
		Ease of Process	1
		Easy to prepare	1
		Desire to be used in different fields	1

The sub-themes and the codes under the Negative Aspects theme is given in Table 3.

6. Results

It has been concluded that the process appeals to the interests of the students, since the students' interest in videos on social networking sites in their daily lives and the fact that most of them already prepare and share videos on various platforms are closely related to the digital story creation process. The data obtained during the implementation process also show that digital stories enable students to develop positive attitudes towards the relevant course. The positive development of student attitudes, which directly affect student behaviors, enabled students to pay more attention to the lesson and complete the relevant preparations for the lesson. Another

finding reached as a result of the research is that digital stories have a great effect on students' motivation. It is thought that students' sharing the digital stories they have prepared in the classroom environment and the positive feedback they receive from their friends, researchers and teachers about the products they put forward have a positive effect on student motivation.

Table 3. The Codes and the subthemes under the negative aspects theme

Themes	Subthmes	Code	*f*
Negative Aspects	**Technological**	Lack of equipment	2
		Internet connection	2
		Internet limitation	1
	Student	Noise in audio recordings	2
		Computer adaptation	2
	Process	Lack of time	1
		Video creation process complexity	1

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The Effect of the Consequence Wheel and the Priority Pyramid on the English Speaking Skills in Online Lessons

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Abstract. This action research aimed at improving the speaking skills of 12 th grade students in online lessons. It was observed that 12 th grade students do not volunteer to participate in speaking activities in online English lessons and they are having problems expressing themselves in English. It was aimed to improve students' English speaking skills using the consequence wheel and the priority pyramid. The participants of this study mainly consisted of 6 female students, who have internet access, are studying at Anatolian High School in the small town of Afyonkarahisar. The research data were collected through a focus group interview. The focus group interview was recorded with the permission of the students in order not to lose data. Collected data were content analyzed and codes and themes were presented. In this action research 2 action plans implemented. Codes and themes were determined by the co- researcher in order to ensure the reliability of the data. The reliability value of codes and themes was calculated as 80%. Teacher's diaries and students' diaries were kept to reflect the process during and after action plans. It was observed that the consequence wheel and priority pyramid affected the students' speaking skills significantly. Findings showed that students' communication skills developed in the L2 language.

Keywords. Action Research, Consequence Wheel, English Speaking Skill, Priority Pyramid.

1. Introduction

English has a priority in the curriculum in Turkey, as in the rest of the world. It is crucial to speak English in order to follow the developments in the world and to be in contact with the world. There are four basic skills in English: reading, writing, speaking and listening. The four skills are interrelated, and the development of one skill affects other skills. The four skills should be actively used while learning and teaching languages. But for most language learners, the ability to speak is a criterion for knowing the language. For language learners, speaking skill is a skill that is more than the ability to read, write and makes sense of oral language, as it enables being fluent in the language and communicating with others. In addition, language learners consider speaking skill as the most important skill as they can evaluate their progress in oral communication skills [3].Speaking skill is one of the four essential skills for effective communication in any languages, especially when speakers do not use their native languages. Since English is a universally used as a communication language, especially in the internet world, English speaking skills should be developed together with other skills [4]. The ability to speak English or in any other language is very important. The greatest task of language is to communicate, and communication is most easily and effectively accomplished by speaking. As mentioned, the ability to speak for language learners is a criterion in language learning, and those who can speak the target language can express themselves better than those who do not. Developing speaking skills is one of the main goals in teaching English. To make students acquire speaking skills in face-to-face education in the classroom environment is quite challenging and takes time compared to other skills. Appropriate methods and techniques should be presented to the students to improve their speaking skills, and the students should be encouraged to speak. There are studies including English speaking skill in literature, [1-2, 5-6, 11-12]. However there are no studies including the consequence wheel and the priority pyramid to improve the English speaking skills. The consequence wheel develops decision making, critical thinking, problem solving and knowledge management skills. As it develops critical thinking skills, it enables students to see the results visually and to think about the primary and secondary consequences of a particular topic [8].The priority pyramid gives students the opportunity to consider what the most relevant points about the key question might be. It then gives students the opportunity to prioritize their thoughts and explain why they are in such order [8]. In the research, it is aimed to improve the English speaking skills of the students in

distance education by using the consequence wheel and priority pyramid methods. As in face-to-face education, distance education also includes the acquisition of speaking, listening, reading and writing skills. The main aim of the course is to be gained the basic skills of the English course in distance education. It has become even more difficult for the students to acquire speaking skills, which is quite challenging even in face-to-face education, in online classes. In this study, an action research was conducted using the "Consequence Wheel" and "Priority Pyramid" methods in order to improve the English speaking skills of 12th-grade students in online courses. This research is important in terms of showing the development of students' English speaking skills with the methods used in distance education and contributing to the literature.

1.2. Research Questions

- "How can English speaking skills of 12th-grade students be improved during the distance education process?"
- What effect did the consequence wheel method have on English speaking skills in the distance education process?
- What effect did the priority pyramid method have on English speaking skills in the distance education process?
- Can speaking skills be improved with these methods?

1.3 Methodology. Research Design

This study was carried out through action research as it aims to contribute to the English speaking skills of 12th-grade students in the distance education process and to improve their speaking skills. Action research is a reflection of the teachers' work in teaching and solving classroom problems [9].

2. The Study Group

The study group of the action research consists of 12th-grade students of an Anatolian high school in the Şuhut district of Afyonkarahisar province. There are 31 students in the class however 6-8 students attend English lessons during the distance education process. The study group consists of 12th-grade students of 6-8 people.

Participants are 18-year-old high school students. All of the participants are female students. All students are studying for the university entrance exam. The students who attend the class have been participating English classes since the beginning of the semester and they have internet access at home. Two of the students live in a village of Şuhut and one of them lives in Afyonkarahisar, and the other students live in a town close to Şuhut. The socio-economic levels of the families of the students were not high, besides the father of two students and the mother of one student passed away. Although students generally like the English lesson, they have problems speaking English.

2.1. Data Collection and Analysis

More than one data collection method is often used in action research and data can be collected by both quantitative and qualitative methods. In this research, data triangulation was done through teacher's and students' diaries and focus group interviews. While the teacher made a general evaluation and the missing points of action plans in the teacher's diaries; she also asked the students to write their opinions about the action plans in their students' diaries. At the end of the action plans, the teacher held a focus group interview with the students and asked the students for their opinions about the action plans. In the focus group interview, the teacher asked the students semi-structured interview questions prepared by taking expert opinion. The consistency of the obtained codes and themes with the co-observer was checked. The concordance between two different researchers was calculated according to the formula suggested by [7], and the result obtained was found to be 80 % (Reliability = Consensus/Consensus + Disagreement X 100).

2.2. Focus Group Interview Questions

- Do you think that the consequence wheel method contributes to your speaking skills in English class?
- Does the consequence wheel method have positive and negative aspects? What are they?
- Do you think that the priority pyramid method contributes to your speaking skills in English class?

- Are there positive and negative aspects of the priority pyramid method? What are they?
- Do you want these two methods to be used again in the English lesson? Why is that?

2.3. Implementation

1st Action Plan

In the first action plan, the students were provided with a speaking activity on the questions following a reading passage from the 4th theme (Coming Soon) in the 12th Grade MEB English book. The implementation of the action plan followed the following stages: First, the reading passage was read together, 3-4 students who had prepared before said the meanings of the sentences; The teacher made up the missing parts. Then, after the questions were answered with the reading passage, the speaking activity part was done.The empty form of the consequence wheel was reflected the students through screen sharing. The teacher informed students about the consequence wheel and she also gave an example of its usage.

In the second lesson, the consequence wheel was reflected on the screen and students were supposed the guess consequences of the concept that were in the activity. The students had difficulty in remembering English words and tried to express them in Turkish. However, the teacher helped the students and encouraged them to say results by using the phrases "I think, I suppose, I believe". The teacher reminded the students that the results of a concept written in the centre of the consequence wheel could be positive or negative. The students did not participate at the expected level and kept their microphones off.

Although 3 students used Turkish most of the time, they made sentences with the help of the teacher. The consequence wheel was used for 4 English lessons in the first action plan. Although the consequence wheel helped to improve the students' English speaking skills, students got tired of trying to find the positive and negative results of the central concept. The students did not want to talk because they had difficulty in finding results. Therefore, after having a meeting with 2 researchers and 1 English lecturer, it was decided to implement the 2nd action plan to improve the English speaking skills of the students by using a different method.

2nd Action Plan

In the second action plan, the teacher reflected the priority pyramid the students as a screen sharing and she gave information about the priority pyramid. The students were told that they could rank any subject by taking into account their own priorities. Afterwards, the teacher asked to rank the results in the consequence wheel according to their importance – the most important at the top of the pyramid, the less important one at the bottom. Two of the students were eager to rank according to their priorities. Emphasizing the priority pyramid of 2 different students, the teacher asked the other students to make the priority pyramids as well. The teacher asked questions to the students about the priority pyramid that two students had done. The teacher asked the student why the result she wrote in the first row was important to her and why the result she wrote in the last row was less important to her. The teacher tried to guide the students by encouraging them and giving hints. She asked the students who did not attend the lesson to create their own pyramids and to send them to her via mail and SMS.The teacher and the students read the reading passage of "Six positive effects of smiling" in the 5th theme (Psyschology). Questions about the reading passage were answered. Students were asked to prepare their own consequence wheels about the reading passage. After the second action plan, it was seen that the priority pyramid contributed to the English speaking skills of the students and could be used in English lessons. After the 2nd action plan having a meeting with 2 researchers and 1 English lecturer, 3rd action was planned to guide future researchers.

3rd Action Plan

The consequence wheel and priority pyramid helped students think creatively and prioritize. It enabled them to consider events from a wider perspective and to think about all the consequences of a situation. Another action plan proposal with these two methods is to ask students about their priorities in life with a priority pyramid, or to make a priority pyramid order related to a topic in the discussion section

of the textbook.In cases where the priority orders of the students are the same or close to each other, a speaking skills activity can be done by writing the most important issue in the centre of the consequence Wheel and its results.If there are few students in the class, the teacher can distribute the consequence wheel template allowing each student to create their own consequence wheel. At the end of the activitiy, the consequence wheel can be discussed with the students.

3. Findings and Comments

Themes were formed in the context of the questions asked to the students in the focus group interview. The themes obtained as a result of the analysis of the focus group interview are shown below.

- The contribution of the consequence wheel
- The positive sides of the consequence wheel
- The negative sides of the consequence wheel
- The contribution of the priority pyramid
- The positive sides of the priority pyramid
- The negative sides of the priority pyramid
- Reuse of the methods

In eaah themes there are codes that show methods are useful for improving English speaking skill.

When the interview data are examined, it is seen that the students have positive thoughts about the methods and the methods contribute to their speaking skills. The students stated that the negative aspects of the methods were difficulties in making decisions or choosing the negative one from two options. They stated that the methods contributed to the learning of English vocabulary, being able to make sentences and thus contributing to speaking skills. Students generally prefer both methods to be used in English lessons; They stated that the methods contributed to their speaking skills, helped them to look at things from different views, and they learned vocabulary to speak in English class.

However, for the priority pyramid, three students out of six mentioned that the priority pyramid contributes to speaking skills and pronunciation and allows learning new words. the other three students said that it did not contribute to their speaking skills, or that it made a very small difference. Although there are differences of opinion in terms of the contribution of the priority pyramid to speaking skills, they mentioned that it is very useful when determining their priorities in life. In the focus group interview, six students in the focus group interview stated that they would like the methods to be used again in the English lesson, to the question of whether they would like the methods to be used in the English lesson. The students stated that the methods increased their desire to speak English and they wanted the methods to be used again in the lessons.

When the teacher' and students' diaries were examined, it was seen that the students liked the methods and contributed to their English speaking skills. In addition, the students stated that the consequence wheel and the priority pyramid let them see from different perspectives of the events and they would use them in their daily lives. When the teacher's diaries were examined, the most difficult points for the teacher were that the students turned off their microphones and cameras. However, in general, it was mentioned in the teacher's diaries that the students liked the methods and methods contributed to their speaking skills. In addition, information about how students liked the methods and they would use them in their daily lives were also mentioned in the teachers' diaries.

4. Conclusıon and Discussion

In this study, an action research was conducted using the consequence wheel and priority pyramid methods to improve the English speaking skills of the 12th-grade students during the distance education process.

At the end of the research, the teacher's and students' diaries ragarding the action plans implemented were examined. In the teacher's diaries, it was stated that the students turned off their microphones and cameras while the teacher was using methods. It was also examined that the teacher had difficulty in

interacting with the students whenever she wanted and all the students attending the lesson did not want to attend the lesson. However, the positive feedback of the students after the lessons and the fact that there were 2-3 students who wanted to speak continuously in the lesson gave the teacher a clue about the effectiveness of the methods. When the students' diaries and focus group interview data were examined, it is seen that the students generally found the consequence wheel and priority pyramid method positive.

At the end of the study, the students stated that the methods used contributed to their speaking skills, corrected their pronunciation, and learned vocabulary to speak in the lesson after the implementation of the methods. However, while the students agreed that the consequence wheel contributed to the speaking skill and enabled to learn new words, three of the six students said that the priority pyramid contributed to the speaking skill and the other three students said that it did not contribute anything or very little. The methods used helped students to be able to speak without any prior preparation and to improve their English speaking skills. Lumettu and Runtuwene (2017) also suggested in their study that impromptu speaking can be used to improve speaking skills in English classes. In their study, they observed that students who were given impromptu speech were more fluent in speaking. They stated that the reason for this was that the students learned to use their own sentences and creativity. As a result, when evaluated with the limitations of the research, the consequence wheel and priority pyramid can be used in English lessons to improve students' English speaking skills.

As a result the conequence wheel and priority pyramid not only helped students to improve their English speaking skills, but also they allow them to think creatively and prioritize. It enabled them to consider events from a wider perspective and to think about all the consequences of a situation.

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Online and Remote Outreach Lectures on Physics Concepts

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Abstract. Periodic surveys on the social perception of science and engineering show the need for intense activities that bring aspects of scientific literacy into the classroom that encourage citizen participation. In particular, these include non-epistemic aspects related to the sociology of science (which are often not transferred to the classroom) [1].

Figure 1. Lectures in schools

In the last five years, a program of free experimental Outreach Lectures on Physics Concepts in secondary and high schools in Galicia has been conducted. The program helps to relate the curricular contents of these educational levels with those taught in engineering degrees at the University. This shows the importance of science and engineering to the future society, our students. Since the decisions made by high school students regarding the future choice of subjects are often determined by factors such as liking for a subject, perception of personal value and competence, career and academic guidance, and information [2] one of the objectives of our Outreach Lectures is to create new vocations [3]. About 130 groups have participated in this program of active, playful, and participatory Outreach Lectures since 2017, with interaction with more than 5000 students and 300 teachers from secondary schools in Galicia [4].

The Outreach Lectures are designed to involve and motivate students in their learning of Physics contents by making use of common material in realistic practical demonstrations. An activity designed in general to provide an interactive learning experience through entertainment and enjoyment and, in particular, to facilitate discussion of Physics concepts by merging informal and formal learning [5].

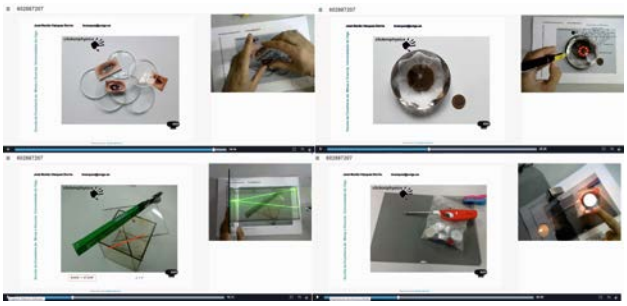

Figure 2. Some screenshots of the University of Vigo's learning management system for Online and Remote Lectures

Figure 3. Online and Remote Lectures in schools

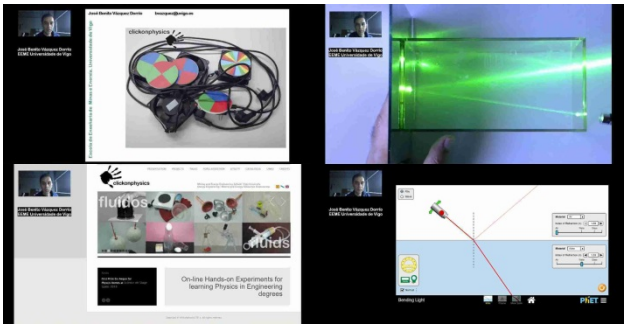

Figure 4. Some screenshots of combination of different resources with the OBS virtual camera

The Outreach Lectures begin with a presentation that provides the context for learning these concepts in primary and secondary school. Subsequently, a set of activities with inexpensive equipment are organized as useful resources that help students visualize, understand, and connect with the formal content. During the Outreach Lectures, relationships are established to help explain some aspects of scientific work and it is related to the research being done in the Engineering Schools of the University of Vigo,

strongly related to the research being done in other international contexts. Since the practical demonstrations arouse students' interest, facilitate learning, are short and easy to perform, these visits are also intended to encourage teachers to progress in their daily work, since teachers must innovate, must develop new educational material and must present new methods of interaction with their students.

During the COVID 19 pandemic circumstances, visits (Fig.1) to the schools [6-7] were combined with Online and Remote Lectures [8-9] using (Fig. 2) the University of Vigo's learning management system [10]. In this second case, groups of students connected directly to our virtual classrooms during their regular class (Fig. 3). A remote system that combined, for example with OBS (a free and open source software for video recording and live streaming) [11] as a virtual camera (Fig. 4), allows the live broadcasting with the share of multiple cameras, presentation programs, online simulations, web pages, videos, etc. Subsequently, a recording of the Online and Remote Lecture using these media is sent to the schools and disseminated among the participating students and the rest of the educational community through its school's website.

This paper presents the methodology and media used, some examples of the activities broadcast, as well as the main results of this experimental lecture program carried out during the current COVID 19 pandemic situation.

Keywords. Physics, Experimental Science Teaching, hands-on activities, Online and Remote Lecture, Outreach,

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Application of the Interrupted Case Method in Undergraduate Chemistry Teaching

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Abstract. The case study method is being ever increasingly used for formal instruction in science teaching, where students are encouraged to discuss dilemmas faced by characters through narratives and to find and argue in favor of solutions. By doing this, the method favors students' curiosity, desire to continue interacting, identifiying problems, searching for information, questioning and confronting results, proposing solutions to problems and arguing [1-3].

There are several types of case study. One of them is the interrupted case method, which presents the problem in a progressive disclosure format. According to Herreid [4], in this method, the narrative can be developed by following the content of a research article, and therefore the interrupted case portrays a problem that was faced by researchers in a certain area.

This work aims to report the development of teaching activities based on solving interrupted case studies, applied to second semester students of an online Chemistry undergraduate degree course, due to the restrictions imposed by the COVID-19 pandemic. Three interrupted cases were created based on three research articles from the Química Nova Journal [5-7], which address contamination of water resources by heavy metals and its effects on human health.

The cases were divided into four parts that have two different sections: a narrative, through which information about the problem was presented; and questions, which subsidized research activities and seek for solutions. The parts were constructed aiming to contemplate the application steps proposed by Herreid [4], which, in short, include raising hypotheses (Part I), outlining an experimental procedure (Part II), arguing the outlined experimental procedure (Part III), interpreting data, discussing results and evaluating solutions (Part IV).

The class was divided into groups of 4-5 members, and, with the cases on hands, eight meetings were carried for their resolution, on Google Meet and Tidia-Ae virtual environments.

Initially, the fact that the students participated actively in the meetings is highlighted. From the discussions held on Google Meet and the written material produced by the students at Tidia-Ae, it can be observed that the cases provided rich debates among students and stimulated participation in the activities. From the application, chemistry content associated with the theme of the cases was discussed, such as bioavailability of metals, bioaccumulation, biomagnification, sediments, and maximum recommended and maximum allowed values, etc.

The information presented in the written material was aligned and coherent with the content of the research articles that gave rise to the cases [5-7], demonstrating the adequacy of the activity to the level of knowledge of second semester students and its relevance to the development of content and skills of different natures, including argumentation.

This work highlights the possibility of elaborating and applying a teaching sequence based on the resolution of cases, which carry in its core desirable authenticity for the development of content and development of skills in chemistry education.

Acknowledgements

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Demystifying the Basics of Image Processing with OpenCV and Python

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Abstract. Electronic Vision is becoming widely used in many kinds of electronic devices to automate or optimize many tasks especially to help humans. With the increased use of Robots or Agents, traditional RGB cameras, RGB-D, thermal cameras as well as lidars, are being used to grab the surrounding environment, being those images processed with computer vision and Image Processing algorithms specially developed for that purpose.

The LAR - Laboratory of Automation and Robotics at the University of Minho, carries out research and development on mobile and autonomous robotics, where most of the projects use computer vision. Both traditional image processing techniques [1-5] and machine learning techniques [6-8] are being used to achieve the objectives of each project.

Normally, image processing is associated with highly complex algorithms, which is not always the case. This work intends to demystify the basics of image processing

Some computer vision projects developed at the LAR will be shown and the solutions described, namely an autonomous driving system, a face recognition system, and the CHARMIE project, and a second part where very simple examples of programs/solutions to work with vision, using Python Language and OpenCV library are presented. This intends to teach newbies how to start projects with computer vision.

Keywords. Computer Vision, Examples of Project, Image Processing, OpenCV, Python.

Acknowledgements

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Important to thank all the Master and PhD studends carrying out research and development in the LAR – Laboratory of Automatiobn and Robotics.

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COVID19 Pandemic II Wave in India: Role of Scientoons and Scientoonics

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Abstract. Coronaviruses are a large family of viruses which may cause illness in animals or humans. In humans several coronaviruses are known to cause respiratory infections ranging from common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). COVID-19 is the infectious disease caused by the most recently discovered coronavirus. This new virus and the disease were unknown before the outbreak began in Wuhan, China, in December 2019. The most recently discovered coronavirus is COVID-19. After assessment, WHO characterized COVID-19 as a pandemic and declared it on 11 March, 2020. The novel coronavirus (COVID-19) cases have been confirmed in large number of countries. The top worst affected countries in the world are China, Italy, USA Spain and Russia. The novel coronavirus (COVID-19) cases have been confirmed in large number of countries. The top worst affected countries in the world are China, Italy, USA Spain and Russia. At present 212 countries in the world are affected by COVID-19 virus. Globally, as of 3:33pm CEST, 12 June 2021, there have been 174,918,667 confirmed cases of COVID-19, including 3,782,490 deaths, reported to WHO. As of 9 June 2021, a total of 2,156,550,767 vaccine doses have been administered.

The second wave of covid19 in India started in March 2021 and the main reason behind this was perhaps the carelessness, negligence and not following social distancing practices properly. In the second wave unprecedented infection in the lungs occurred in many corona patients causing lung damage and resulting into the higher demand for oxygen.

What is most important today being that people are not aware of the precautions to be taken in order to save them from covid19 pandemic. The second wave of covid19 pandemic created havoc in India. Author has started a novel concept of science communication and a novel hands on science activity Called scientoon (a new class of cartoons based on science) and subsequently a new science called Scientoonics, will use this science to create awareness about covid19 pandemic spp. vaccines, immunity and role of oxygen etc.

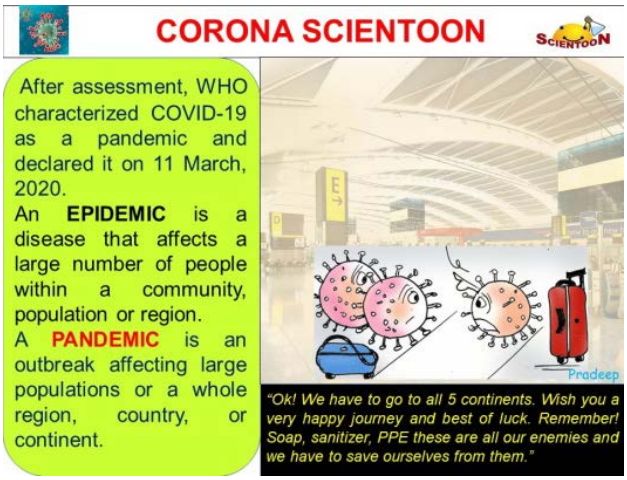

Figure 1

Keywords. COVID19 Pandemic, Scientoons, Scientoonics.

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Determining Preschool Children's Opinions about Science and Scientist through Short Stories

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Abstract. Curiosity is one of the most distinctive features of preschool children. Children have a natural tendency to explore and learn. Learning begins at a very early age and continues throughout life. Children have a great enthusiasm for learning and exploring even before they start school. They are in a constant state of curiosity and research to explore and learn about their environment. They ask everything, research and wonder. It is extremely difficult to reveal the views of especially preschool children about science and scientists only through questions. For this reason, in this study, the views of preschool children about science and scientists were tried to be determined through short stories. In-depth short stories were preferred in this study in terms of being shaped in their own naturalness, being flexible and providing in-depth knowledge on a certain subject. This research was designed qualitatively and the case study method was used in the research. The participants of research consist of 75 children aged between 48-72 months studying in five kindergartens selected from city center of Afyon, the town of Sinanpaşa and Susuz. As a data collection tool, story cards were created through pictures from the book named Makara of Tübitak publications, which was decided by expert opinions. The pictures of book chosen in order to determine the perceptions of children about science and scientists were turned into enlarged story cards to attract the attention of children. Picture story cards prepared by the researchers were read collectively to preschool children and classes in schools attended for research. The questions of story were asked to children individually and the opinions of children were taken individually. It took 15-20 minutes to read the short story to children and to get answers from children. Obtained data were noted. According to study, it was determined that preschool children associate their perceptions of science and scientists with the people and objects in their environment and daily life. As a result, it was observed that perceptions of preschool children towards science and scientists do not perceive the concepts of science and scientist very much according percentiles. It was determined that expressions they perceived were related to story and gave examples from their daily lives, while some children did not answer the questions.

Keywords. Preschool, Science, Scientist, Short Story.

Lab in a Box, Future with Science

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Abstract. Lab in a Box, Future with Science is a STEM education project created by scientists and science communicators working at the Instituto Gulbenkian de Ciência (IGC) in Oeiras, Portugal, to galvanize the practice of experimental science in schools in Portugal and portuguese-speaking countries. Although science is a major driver of development and a more conscious citizenship and experimental science is a powerful tool to encourage critical thinking, our children are not sufficiently instigated to use scientific ways to question and understand the world around them, and experimental, hands-on science is not a common practice in our classrooms. The Lab in a Box (LiB) project is an answer to this challenge. Its target audience is teachers and, by extension, their students, and is financed by the IGC and its (public authorities and industry) partners. The project's first (pilot) year (2020/2021 school year) was implemented in schools of the municipality of Oeiras, with teachers lecturing 6 to 12 year-olds, and later this year will be brought to teachers of schools in Benguela, Angola and in S. Tomé e Príncipe (STP).

At the beginning of their training, teachers receive the centerpiece of the LiB project, a portable, modular and low-cost kit (or box), carrying all the materials needed to carry out appealing experimental STEM activities. As we shall describe in this presentation, the box contains low-cost, commonly used, easy to replace materials in sufficient quantity for various groups of students, so that the activities are truly hands-on for all children. The box also contains a guide with detailed instructions for the teacher and a lab notebook for the students. The activities are integrated in the curriculum of the discipline and school year for which they are intended and adapted to the local context. Each LiB activity is intended for students to learn to observe, ask questions, pose hypotheses and experiment; to acquire and evaluate information; to potentiate their critical thinking skills and to bolster their scientific curiosity; to deal with uncertainty and unforeseen events; to value different opinions and to collaborate; to assume attitudes and values that promote sustainability and civic responsibility. All LiB activities have at their core a very strong emphasis on environmental literacy and sustainability. In addition to the kit (the box), the LiB project includes and invests heavily in accredited teacher training, classroom monitoring, online resources and a constant sharing of experiences between LiB teachers and scientists.

The COVID19 pandemic presented us with an unexpected challenge, as the Lab in a Box is a hands-on project with a strong emphasis on teacher training by IGC scientists, wherein the practice of hands-on science and social interaction are essential for learning. Indeed we had planned to conduct *in person* teacher training workshops, at the IGC with Oeiras teachers and, later in the year, in person, in Angola and STP, which the pandemic jeopardized. But at the same time, COVID19 restrictions fostered our creativity and made us consider alternative forms of implementation. It forced us to develop and test new experiments with only the resources we had at home, which generated original ideas, and made us invest more in the production of online content. It also made us fully embrace online alternatives for teacher training, in which we scientists at the IGC improvised a studio in which we performed the experiments together with our teacher trainees (with their LiB kits) in their schools/homes (depending on COVID-19 confinement stage), with surprisingly positive results.

As we shall discuss in this presentation, the COVID-19 pandemic brought about some unexpected "advantages", namely by creating a context in which we were forced to hone in our online training skills, unwittingly equipping us to be able to conduct our Angola and STP teacher training sessions, later in the year, without the need for (costly) international travels.

Keywords. STEM, Science Museum.

The Experimental and Historical Foundations of Electricity

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Abstract. In this talk we make 4 experiments: (a) The rotation of a versorium by an electrified straw (instrument due to William Gilbert in 1600); (b) the Attraction/Contact/Repulsion of an electric pendulum made of a paper disc suspended by a silk thread (instrument due to Stephen Gray in 1720 and ACR mechanism due to Du Fay in 1733); (c) the levitation of a dandelion seed with an electrified straw (experiment due to Guericke in 1672); (d) charging and discharging an electroscope (made of cardboard, a thin paper strip, and supported by a plastic straw) in order to distinguish conductors and insulators.

We present some aspects related to the history of electricity which can be constructively explored in physics teaching. In particular, we discuss the amber effect, the attraction of a thin water stream by an electrified straw, the electric attraction and repulsion, the mechanism of attraction/contact/repulsion, conductors and insulators together with some of their main properties. We show how to build cheap instruments like the versorium, the electric pendulum and the electroscope. They are simple devices but very sensitive and extremely important in the history of electricity. We compare the low-cost electroscope with the gold leaf electroscope.

We present the usual explanation for the amber effect (attraction of light objects like bits of paper by an electrified straw) and for the deflection of a thin stream of water by an electrified straw. We emphasize that we do not agree with the explanations of these two phenomena which are given in the textbooks.

We call attention that some of the main discoveries in electricity happened very late in the history of science. Isaac Newton (1642-1727), for instance, did not know the distinction between insulators and conductors of electricity. This discovery was made by Stephen Gray in 1731. Moreover, Newton did not know about the existence of positive and negative charges. The discovery of two kinds of electricity was made by Du Fay in 1733.

Finally, we discuss 3 mysteries related to the amber effect which have not yet been completely solved, although this is the oldest experiment of electricity with some 2500 years. For instance, we know Coulomb's law q1q2/r^2 which explains the attraction of charges of opposite sign. 1st mystery: (a) What is the origin of the force which SEPARATES opposite charges during the friction of two bodies? What is the law satisfied by this unknown force? Textbooks mention that there is a transfer of electrons during frictional electrification. 2nd mystery: (b) Is frictional electrification really due to a transfer of electrons? What are the experiments which support this assumption? 3rd mystery: (c) What is the origin of the force which prevents the explosion of a positively charged sphere or the disintegration of a positively charged straw? What is the law satisfied by this unknown force?

This talk in based on the 2 volumes of the book "The Experimental and Historical Foundations of Electricity", [1] and [2]. A similar approach to mechanics was presented in the book "Archimedes, the Center of Gravity and the First Law of Mechanics: The Law of the Lever", [3]. These books are based on hands-on experiments made with simple material. These experiments are combined with historical discussions of the subject and many quotes from original sources. These 3 books are freely available in PDF format in English, Portuguese, Italian and Russian, [4].

Keywords. Controversies, Electricity, Hands-on Experiments, History of Physics.

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Animated Scientoons: an Opportunity in Distant and Online Teaching and Learning Science

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Abstract. It is been always a tough job for science communicator to make science simplified and interesting. In the era of digitalization and particularly distant learning or online studies, the long study material is difficult to present. Making the presentation of scientific fact is always been challenging even in person and so in virtual too. If cartoon characters are coming to science communicator or science teacher, shake hand with them and say don't worry, we will help you out in making science interesting with funny facts, laughing language, cute cartoon, good-looking graphics without losing the depth is science or scientific information. Scientoon is such a blending of scientific fact and humour. Scientoons are cartoons with scientific information about new research, facts and figures, the history of science, the life of scientists. In the era of digitalization where media presentation is breaking the boundary of still images or simply drawing animated films with sound and music. Taking to scientoons to a new height and making them animated will help in getting more attention toward science communication. Imagine a dancing DNA or orbing electron with talking neutron and waving hand by glucose molecule in animation. Walking and talking sodium element and chlorine element are ordered by the chef to react and make food tasty in the animated form will help in inculcating the concept of science. In this presentation wide range of animated scientoon will be covered which include animals talking about the conservation of their habitat, the plant will talk about their role in the ecosystem; Newton and Einstein will have a virtual discussion with Mendeleev about coronium and newtonium. Micky and mouse will attend science class and make trouble to their science teacher will make the science learning funny and innovative..

Keywords: Animation, Scientoon, Science Education, Online Studies.

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Author thanks to Dr Pradeep Srivastav, famous scientoon maker and Ex Deputy Director of CDRI, Luknow, India for continuous inspiration.

Chemical Degradation of Synthetic Polymers Surgical Masks

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Abstract. With the Covid-19 pandemic, the consumption of surgical masks soaredworldwide [1]. To prevent the spread of this respiratory disease, it became mandatory to use masks in several countries. The masks are mostly constituted by polypropylene. In this way, the massive use by the population of these products may be a potential risk to the environment and health. The disposable face mask that gets to the environment, discarded in landfill, oceans or littering at public spaces, etc., could be emerging a new source of microplastic [2]. This project aims to evaluate the decomposition of masks when subjected to aggressive environments (acid and base) and subjected to environmental conditions for a certain period of time.

We also left a mask buried in the ground, subject only to environmental conditions, for 3 months.

The chemical "attack" was carried out in surgical masks (the masks were cut into pieces of approximately the same size) with three different solutions: HNO_3, HCl and NaOH under stirring for 24 h At the end of time, the sample masks were washed with distilled water and dry. Following, the sample masks were analysed by FTIR to evaluated degree of decomposition. The project we had the opportunity to carry out allowed us to understand why there is still no ideal treatment for surgical masks that are discarded in unsorted garbage, contrary to medical waste masks that are subject to disinfection treatment before their disposal.

Based on the FTIR profiles, the changes in the components were not significant, since the variations between the initial mask and after being subjected to each of the two acids and the base (HNO_3, HCl and NaOH) were practically nil (they were not easily visible), as well as the mask only subject to environmental conditions for a few months. Thus, showing, in almost all, the same characteristics between the beginning and the end of the experiment, we can say that its degradation was practically nil, since there are no significant alterations in the polymeric structure.

It was possible to conclude that the material that makes up the masks is quite resistant, not being easily degraded even under severe conditions such as those used in the tests. Therefore, it is expected that this type of material when discarded into the environment will remain intact for a long period of time. However, there are already some alternatives to this plastic material.

Keywords. Covid-19, Environment, Mask, Pandemic.

Acknowledgements

We would like to thank professor Silvia Pinho, from FEUP (University of Porto), for guiding us throught out the project.

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Contributions of Postgraduate Studies in Brazil to the Academic Impact of the United Nations: a Rapid Narrative Review

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Abstract. The nature-society relationships have gone through, in recent times, spatial transformations that generate crises and human unsustainability. Spatial or ecosocial sustainability challenges are complex and began attracting attention in the 1970s, precisely at the first United Nations Conference on the Human Environment, held in Stockholm in 1972 [1-2]. However, knowledge of the support, commitment and academic impact of the higher education institutions (HEIs, hereafter), specifically the postgraduate, on the principle of sustainability in the educational setting is little known or scarce. As such, the aim is to conduct a narrative review of the literature regarding the academic impact of graduate programs in Brazilian HEIs, using dissertations and theses, demonstrating support and the commitment to promoting sustainability and quality education. This is a narrative review study of academic articles published between 2016 and 2019. On the Brazilian Digital Library of Theses and Dissertations. The survey identified 18 dissertations and 7 theses that met the research goals. The articles analyzed from graduate programs of HEIs in different areas of Brazil demonstrated the ecosocial, intellectual and educational responsibility of these institutions, in compliance with the United Nations Academic Impact initiative [3]. The narrative review shows that the articles produced on the impact of sustainability and quality education, especially by HEIs, were primarily case studies concentrated in specific institutions and the impacts on society and its experiential setting. The impact of academic studies on sustainability demonstrates the intellectual responsibility of HEIs in the face of spatial or ecosocial challenges.

Keywords. Higher education. Postgraduate. Sustainability. United Nations Academic Impact. Rapid Narrative Review.

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Scientoon Creation and Teacher Education: a Case Study

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Abstract. The teaching can end but education cannot! The unique time pays unique qualities. The role of teacher education institution is to prepare teachers for the next generation and for all time needs. This paper aims at exploring opportunities of teacher education to make science and its learning process simplify. Cartoons are one of the most near and dear form of interest in the children of any era. Creating cartoons for science and other subjects and to use it for learning process will pay a very fruitful result. It is the role of teacher training institution to give such opportunities to florish the imagination, skill and creativity of trainees. During workshop conducted for the teacher trainees, a project was undertaken creating Scientoon. The paper is about the case study of the work undertaken in the workshop by the trainees. Objective of the workshop was to make them aware about the use of cartoons in education. The aim was to make trainees know how to cartoonize the topics to be taught and to simplify it by putting humar in it. So, the cartoons were prepared by trainees with a zeal and put as “Abhyastoon” for veriety of areas to be studied. The distant and online teaching has become challenging, but such creation is more rewarding in terms of process and results too. It was also aimed at providing a short training to the trainees to prepare Scientoon. The output of the online workshop came up with fruitful 400 Scientoons and Abhyastoon.The process of involving teacher trainees will be multiplied and will lead a great extent of understanding with a very pleasant process. This has proved that online education also has worthy outcome.

Keywords: Education, Online Teaching, Scientoon, Teacher Education, Distance Education, Online Studies.

Home-Making Videos Help Students to be More Communicative

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Abstract. Communication skills are one of the most important skills that help us better understand the situations and people, and have a crucial role on being a successful citizen. So curriculum designers and educators design and prepare a lot of activities, contexts and educational environments for improving different communication skills of students such as writing, verbal and nonverbal. So that, they need to practice all of these skills in daily educational programs.

Covid-19 changed the education environments and teaching-learning methods. So that schools mostly were closed and face to face education replaced by online, virtual and distance learning. Under this situation, teachers tried to use different applications for getting learning objectives. The connection with students came down, monitoring of students during the teaching session became more difficult. In some cases students even did not know who their teacher is and how he or she is. The situation was disappointment and it was expecting that communication skills will not be flourished or going to be very weak. But I had several experiences in primary school as an educational inspector that they sound good. I was watching the videos of student that they made by themselves using social network tools and facilities. They have surprisingly used oral skills and body language for transmitting their messages clearly and concisely. I was wondering, how it is happened? I found that when a girl or boy preparing his or her video for sending to their teacher, she or he watches his or her home made video and revise it for several times. Indeed they have enough time to make their video better and better in a stress less environment and enjoy own success. One thing that we need to know is the student's home-made videos mostly focused on reading and talking. Anyway these activities helped them to be more confident in giving explanation for questions and more successful in using social networks. Of course they may have sense that some news in the social network are fake and they need to check them from different sources.

Keywords. Communication Skills, Home Made Videos.

Views of Students from an Integrated Middle Level Technical Course in Brazil on Scientific Inquiry

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Abstract. In this technical-scientific informational period during a spatial crisis, the scientific inquiry (SI) has become relevant, mainly due to the fact that, in the teaching-learning process in high school in Brazil, it started to have as a great ally the Brazilian National Learning Curriculum (BNCC) by the Ministry of Education, published in 2017 and acting in the country [1]. This Brazilian document states that it is necessary that the school welcoming students at this level of education must fulfill its commitment to the scientific-technological foundations of knowledge production, integrating different areas of knowledge towards a better literacy or scientific understanding that enable the formation of autonomous and critical thinkers in the face of current challenges [2-4]. However, the everyday reality of the high school classroom is far from the full reach of this commitment to the BNCC, as the SI still seems to be a very limited reality in the context of the classroom, not only in high school, but of basic education as a whole (involving the previous kindergarten and elementary school). In a particular situation, the importance of SI, in the teaching-learning of technical courses at the high-school integrated level of the Federal Institute of Science and Technology of Rio Grande do Norte (IFRN), Brazil, has been a reality since 2012, when the implementation of its new Political-Pedagogical Project happened [5]. This document includes four curricular seminars (namely: Academic Integration, Quality of Life, Initiation to Research and Guidance for Professional Practice) that are articulators of the propaedeutic and technical disciplines, among which the Initiation Seminar for Research stands out (SIP), aimed at articulating theory-practice as a fundamental attitude to the complementation of knowledge and skills in the direction of scientific education in the integrated technical courses at IFRN. However, there is no current research that captures how science education has taken place at the institution, and the knowledge and understanding that students have about SI has not been investigated so far. Therefore, the objective was to know the views of students from two SIP classes of the academic term of 2021.1, of the second year of the IFRN Environmental Control integrated high school technical course, at the Natal-Central Campus, Natal, Brazil. Data was collected through the Views About Scientific Inquiry (VASI) questionnaire, applied to 63 of these students. The results revealed that most students had little knowledge about SI, predominantly a naive view of SI, as measured by the VASI. This tool can be applied by schools and teachers, since different SI-based curricula are being proposed by secondary education institutions in Brazil.

Keywords. Scientific Inquiry, Brazil, VASI Questionnaire, High School.

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Towards Socio-Ecological Sustainability in Elementary School through Problem Based Learning

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Abstract. The current planetary emergency situation demands a great challenge from education, which is to educate to protect both the Earth and human life. In that regard, the education for socio-ecological sustainability [1] needs to be present in the curriculum and teaching practices of elementary school. The use of active methodologies such as problem based learning [2] can prove to be an alternative in the construction of individuals' critical thinking towards a more sustainable society. The objective of this study is to investigate the perception of elementary school teachers at the Clara Camarão State School about mastering and approaching socio-ecological sustainability towards problem based learning. This is a qualitative research, in which data was collected from 16 teachers through an online questionnaire via Google Forms, focusing on a more comprehensive understanding of their thoughts on sustainability in educational practice. Data analysis, based on theoretical support, was performed using Bardin's [3] content analysis technique. The results showed that teachers have very little contemplated the discussion of socio-ecological sustainability based on problem based learning, demonstrating a certain weakness in the initial and/or continuing education of teachers on the approach to socio-ecological sustainability. It is concluded that although the training of teachers on the subject has proved to be insufficient, it was found that teachers are willing to streamline learning about socio-ecological sustainability at school through problem based learning.

Keywords. Elementary Education, Problem Based Learning, Sustainability.

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Study of Socio-Ecological Sustainability in the Continuing Education of Pedagogy Teachers from the Perspective of Gamification

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Abstract. Higher education is the ideal space for disseminating the approach to socio-ecological sustainability in this century's threshold. However, it has been limited in the curricula of courses at higher institutions, but it can be an action to be taken by professors in the teaching-learning process, aiming to face up to ecosocial challenges. The process of teacher training must take place through training subsidies that take into account the new curricular guidelines, seeking to meet, in a critical and creative way, the changes introduced in the national way of teaching by Law no. 9394, December 20, 1996, Law of Guidelines and Bases of National Education. This law operates in the field of education, with the principles and purposes of national education, the right to education and the duty to educate, becoming a reference in the structuring of the educational system [1]. The aim of this study was to investigate the continuing education of Pedagogy teachers at Faculdade Uninassau de Natal-RN regarding the approach to socio-ecological sustainability in teaching practice towards the promotion of sustainability through gamification. This will allow for the reformulation or renewal of learning spaces, making them more active and dynamic; as well as centered on the role of the teacher as a mediating agent in the teaching-learning process of higher education. These changes allow for a playful, innovative and participatory pedagogy, capable of enhancing motivation, educational performance, improving the person's engagement and experience, through attractive didactic resources, such as learning based on gamification [2-4]. Such an effective process of public engagement, teaching and learning can lead to significant socio-ecological results [3]. The methodology followed the principles of a qualitative, applied and theoretically based research; documental and curricular analysis procedures, as well as survey of primary data from the application of an online questionnaire with 15 teachers. The results of the study point to significant contributions to the improvement of teaching-learning, showing the particular interest of teachers in adequate training, towards an innovative socio-ecological professional profile, made possible by new active methodologies, such as gamification. This will allow for intellectual independence, the improvement of higher education, especially in terms of overcoming a hidden curriculum of unsustainability in force. In short, due to the impossibility of the socio-ecological approach in the context of the Pedagogy course for several reasons, it was possible to build a continuing education course for teachers using gamification, aiming to support the training of teachers in a dynamic and active way for a teach-learn about current ecosocial crises in the educational context. It is concluded that education is an ecosocial transformation strategy, since it is associated with technical-scientific and political changes, but above all the resolution of socio-ecological challenges facing humanity [4].

Keywords. Sustainability, Higher Education, Pedagogy, Gamification.

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Tangible Objects in ESL Classroom: Impact in Learning at Primary School Level

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Abstract. With the launch of the ImpactEDTECH / European Schoolnet Program, several European schools were selected to test, in a pedagogical environment, innovative solutions in the field of Programming and Robotics. Sponsored by the European Commission, this project allowed several schools to have access to innovative materials, still being put on the market, and, in exchange, to test their pedagogical potential. In the specific case, on which we will focus in this article, we will evaluate the impact of the application of small robots, assembled entirely by the students, on the learning of a foreign language, English, as well as on the improvement of the students' communication skills.

Keywords. Coding, English, Otto DIY, Primary School, Robot.

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History of Science in Promoting Argumentation for Future Chemistry Teachers

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Abstract. Considered as a recurrent practice in constructing scientific knowledge, argumentation has been increasingly encouraged in science teaching settings [1]. The present study addresses using a Didactic Sequence (DS) that encourages argumentation in a discipline aimed at the initial training of chemistry teachers in a Brazilian public university. To this end, the building of nuclear weapons was addressed by reading the graphic novel called “Trinity: the graphic history of the first atomic bomb” [2]. While narrating the events that led to building the atomic bombs that were dropped on the Japanese cities of Hiroshima and Nagasaki, the author of the graphic novel mainly uses a historical approach. Some of the main discoveries and scientific concepts related to the theme are presented to the reader, such as: the the Curies´ observation of radioactivity; atomic models explaining the behavior of matter; and the nuclear fission process. DS was used in eight classes (100 minutes each) and included: reading the graphic novel; written activities related to the graphic novel; applying historical case studies extracted from the novel; and evaluating future teachers' arguments regarding the historical cases discussed. At the end of the process, a Likert scale questionnaire was administered so that they could explain their perceptions about DS. Analyzing these perceptions showed that DS was effective in promoting future teachers' arguments about historical scientific episodes. Furthermore, the theme favors the understanding of constructing science and provides an argumentative practice contextualized with the historical moment addressed, which implies an understanding of the political, ethical, moral, economic and social impacts of scientific practices. Such aspects are relevant and necessary for teacher education, as knowledge of different methodological tools, such as graphic novels, as well as an understanding of the importance of argumentation in science can lead to future teachers implementing it.

Keywords. Argumentation, History of Science, Chemistry Teaching, Teacher Training.

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Hands-on an Everyday Chemistry Podcast: the Case of *Minuto da Química*

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Abstract. Podcasts are digital media mostly broadcast as audio files. Its consumption has revealed a true phenomenon, accounting for more than 34 million episodes published around the world. However, among the natural science productions, chemistry is still a topic that is not widespread. At the same time, the approach to public communication of science and technology in the classroom has notoriously contributed to the students' development of criticality, communicative skills and even to support their learning. Based on this scenario, we report, in this abstract, the experience of the American Chemical Society Student Chapter at the University of São Paulo in producing the "Minuto da Química" podcast about everyday chemistry.

All stages of production were coordinated by the students themselves. Initially, a partnership with the Federal University of São Carlos radio with local reach was signed, guaranteeing both online and live publication. The adopted format was the spot-style, lasting up to 3 minutes. Subsequently, the students surveyed the subjects they were familiar with and devoted themselves to writing the scripts, which were structured in: vignette, theme presentation, discussion and farewell slogan. These scripts, in turn, were subjected to peer review, involving university professors and graduate students in reviewing topics of their expertise. Next, the episodes were recorded in studio (seasons 1-2) and remotely (seasons 3-4) by the student-host, edited by the radio producers and weekly published as an interprogram.

The 4 seasons of "Minuto da Química" resulted in 58 episodes (data from August 2019 to June 2021). The experience allowed the communicative exercise and exploration of topics in chemistry, reflected in episodes about Materials Chemistry (17.2%), Medicinal Chemistry (13.8%), Environmental Chemistry (13.8%), Food Chemistry (10.3%), Covid-19 (8.6%), Biochemistry (6.9%), Cosmetics (6.9%), History of Chemistry (5.2%), Synthesis and Organic Compounds (3.4%), Pigments (1.7%), Quantum Chemistry (1.7%), Nanotechnology (1.7%), Inorganic Chemistry (1.7%), Photochemistry (1.7%), Forensic (1.7%), Electrochemistry (1.7%) and Public Perception of Science and Technology (1.7%).

Keywords. Public Communication of Science and Technology, Chemistry, Podcasts.

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COVID-19 Engineering Design Challenge

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Abstract. The University of Texas at Tyler, collaborating with the Texas STEM Coalition (T-STEM) and the International Council of Associations for Science Education (ICASE), created an Engineering Design Challenge for students in primary, secondary and higher education settings to identify challenges related to the pandemic, brainstorm and design solutions, and communicate their ideas to their classmates, families, and community members. Teacher instructions and a sample student project translated into the six United Nations languages (Arabic, Chinese, English, French, Russian and Spanish), plus Japanese, Portuguese and Turkish, are available. The 2020 Challenge included 399 students from 9 countries. Information on how to join the 2021 Challenge, a summary of world-wide participation to date, and a list of the student creations produced as a result, will be provided.

Keywords. COVID-19, Design Challenge, Engineering.

Planning STEM Lessons with Pre-Service Classroom Teachers: Edible Car (Rolling vegetables)

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Abstract. This study reports a sample STEM lesson which was developed by pre-service teachers who were pursuing their third year in Primary School Teacher Education Program of a middle size university located in southeast part of Turkey. Pre-service primary teachers developed STEM lessons which were aligned with the objectives of a lesson they choose among the the topics included in 4th grade science curriculum. Student teachers were first introduced with STEM approach and its theoretical basis and examples of the lessons developed based on STEM approaches were demonstrated by the professor(myself). Student teachers then planned their own STEM lessons as groups and a micro application was created by them. Because of the pandemic they could not perform their lessons in class however they have made a prototype of a product they have developed based on their lesson's objective and demonstrated how it worked utilizing media player or photos of the activity. This example lesson is called edible car which was related to nutritions and healthy diet.

Keywords. STEM, Pre-Service Teachers.

AUTHOR INDEX

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18th International Conference on Hands-on Science

Hands-on Science Education Activities
Challenges and Opportunities of Distant and Online Teaching and Learning

19th-23th July 2021

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